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AMERICA'S NEED OF WIDER MARKETS.

By Hawthorne Hill.

THE most striking feature in the history of the United States has been their development, from a group of English colonies intended as a source of food for the parent nation and an outlet for the surplus from her factories, into a manufacturing country of the first importance. It was a notable address which Sir James Kitson, Bart., as president of the British Iron and Steel Institute, delivered at the opening of the session of that body in October, 1890, for the reason that it contained the first public acknowledgment, from an eminent English source, that the honor of first place in iron-production had passed from Great Britain—perhaps for all time—to the United States. The speaker gracefully emphasized this triumph of the young republic by dwelling upon the prohibitive legislation of parliament by which iron-making was held in check in the colonies until they had attained their independence. Thus scarcely more than a century had been left to the new country in which to outstrip its oldest and strongest rival, not only in the amount of iron produced, but also in the extent of its consumption.

At the beginning of our independence England held, as she supposed, the key to the industry of cotton-manufacture. Certainly she held the machinery without which such manufacture could not be carried on in competition with her own mills, and parliament imposed heavy penalties for the exportation of machines or plans or models of them. But here, too, the law-makers were powerless to shape the channel for industrial progress. There is not room in this paper to trace the history of the manufacture of cotton goods on American soil, which has progressed steadily in accordance with the law defined by Adam Smith, that the natural place for the artisan is in the neighborhood of the producers of the food and of the raw material, where

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both would be cheaper than elsewhere. In the absence of more recent comparative statistics, it may be stated that while the amount of cotton consumed in English factories between 1833 and 1878 increased five-fold, the increase in the United States between 1831 and 1880 was ninefold.*

Iron-making is mentioned here because the industry is universally rated as of the first importance, and cotton because it represents one of England's boasted leading industries and one which, on both sides of the Atlantic, has been intimately connected with the development of the modern factory system. But these are by no means the only lines in which American manufacturers have made their mark. It has come to be admitted that the United States are able to manufacture goods of any character for which an important home demand exists. Welsh tinplaters no longer comfort themselves by the thought that climatic conditions in America will prevent competition with them here, and Sheffield cutlers have ceased to boast that their inherited skill, coming down through many generations from their ancient guilds, will give them a permanent advantage. It is no longer absurd to talk about the introduction into America of manufactures of any kind; no longer are the people here dependent upon foreign mills, and least of all in the metal and mechanical trades.

As a further illustration of American progress, reference may be made to the superb new war-ships, which some English engineers and ship-builders seriously thought, when congress ordered their construction, would have to be supplied from the other side of the Atlantic. Even when the hulls were under way, Englishmen still contended that the engines and armament would have to be imported. Yet the ships so far completed are without a superior in any other country, though designed by Americans—and in some cases at variance with the best European practice—and built of American material by American labor. Thus is marked a wonderful advance from the conditions of a half-century ago, when Henry C. Carey, writing of American industries, said: "In 1842 we produced about 200,000 tons of iron, not a ton of which could be made into railroad iron, for we had no machinery for the purpose."†

The lesson of all this is that American ingenuity has become adequate for supplying American needs. This much having been established, the coming pressing problem will lie in a different direction:

* As illustrating the natural law of development of cotton-manufacture as to locality, we may note that, whereas in 1831 only .6 per cent. of the cotton spindles in America were found in the southern states—embracing the cotton-growing section—these states had in operation sixty years later 8 per cent. of the whole number. The development of the industry has since been more rapid there than in any other section. H. H.

† *The Plough, the Loom, and the Anvil*, October, 1852.

how shall we best utilize the facilities which have come into existence in the supplying of our wants? With existing mills and plants we could provide for a vast population in addition to our own. It is scarcely accurate to say that over-production has resulted, for when the demand in sight is met the production in most classes ceases, leaving the wheels idle and the workingmen without wages. Mr. James M. Swank informs me that during 1893 the production of iron from the blast-furnaces in the United States was not greater than 50 per cent. of their capacity.* In the valuable manufacturing statistics of Massachusetts for 1892 it is shown that, of 4473 manufacturing establishments covered by the report, only 696 were worked to their full capacity, and that for the whole number the production amounted to only 69 per cent. of the capacity of the mills. These figures are not due alone to any temporary conditions; there has been no year for a great while in which a largely-increased production could not have been attained if a market had existed for the goods.

The industrial demand of the day is for markets abroad. The whole people are awaking to it, for the interdependence of interests is such that the legitimate profits of any industry add to the prosperity of all. We have not reached such a situation—but we are becoming able to appreciate it—as led Lord Dufferin to declare before the London chamber of commerce that, if existing political relations in India were disturbed, "there is not a cottage in Great Britain—at all events in the manufacturing districts—which would not be made to feel the disastrous consequences." The question of foreign markets has not hitherto appealed to American manufacturers generally, for the reason that they have had at home, as they still have, an unrivalled market for nearly every conceivable product of industry. To no other quarter of the world have the manufacturers and artisans of Europe turned more longingly than to the United States. The development of our trans-Mississippian wastes into populous and wealthy states, with immense cities and great railways, has been alone a greater achievement than the most extensive colonization work of any European country. It was natural that the intelligent, progressive, prosperous classes in the west should appeal more strongly to New England manufacturers than half-clad tribes in Africa, for instance,—with wants for manufactures yet to be created, with a language strange to us, living in countries almost inaccessible. Neither England nor Germany to-day would be so largely interested in the dark continent had North America continued to depend upon foreign manufacturers.

* Mr. Swank, who is general-manager of the American Iron and Steel Association, writes: "The production of pig-iron in this country in 1893 was 7,124,502 gross tons. The capacity of our furnaces in 1892 was 14,550,708 gross tons. This capacity has not since been reduced, but has probably been slightly increased."

The first Cornelius Vanderbilt read the trend of events aright when he deserted the Atlantic shipping trade and turned his attention to railway extension, as a stepping-stone to vast development in his own country, and other American capitalists emulated his example. There was no lack of enterprise there, no neglect of opportunities, no want of judgment on the whole. On the contrary, development at home, serving to make of the United States a homogeneous nation, solidifying their interests or making them interdependent, and accumulating a reserve of capital in safe fields, has strengthened the country and fitted it now to enter the lists of international trade as a competitor worthy of respect.

This new departure in trade, however, demands a new course of training, as it were. Too many of us do not even know where "the markets of the world" are, apart from such centers as New York and Chicago and Denver. The character of foreign peoples, their languages, and their peculiarities of taste or customs are all a sealed book to us, even when they occupy portions of our own continent. There is perhaps no maker of wooden shoes in the remotest hamlet of Europe who does not know that his wares are not suited to the United States, but the shipment on a venture of refrigerators from this country to points on the equator, where ice is unknown, has been undertaken as a piece of good business. A United States consul at a small seaport in Brazil, who was asked by his government to report whether he had seen any American files in that country, replied that he had, but that the only use the people had found for files was to drive them into a wall for hat-pegs, or something of the kind. Doubtless the manufacturers of these goods, and of many others which have been shipped to Spanish America from our country, are now convinced that it would be a waste of time to try again to sell to people so ignorant. It might be well, as a first step, to learn on whose side the greater ignorance lies.

The most amazing mistake of all is the idea that the congress at Washington can legislate our products into the hands of buyers abroad who may not even know that we have a congress, and without any effort on the part of the producers. Robert J. Walker, coming from an agricultural state to the treasury portfolio in 1845, was much impressed with the idea of legislation to extend the exports of farm-products. In his official estimates he predicted an annual increase in such exports of almost 50 per cent. per year. The fact was that the American exports of articles of food, under the policy he advocated, declined steadily in value from $68,000,000, in 1846–47, to $21,948,000, in 1850–51. We have been scarcely more successful in legislating manufactures into the export column. Under section 3 of the McKinley bill the president of the United States entered into reciprocal arrangements

with various countries, whereby such tariff concessions were secured in our behalf as to alarm certain English manufacturers, and to lead to a demand in parliament that the interests of Englishmen be similarly looked out for. Whether any increased efforts on the part of American exporters followed the "reciprocity" arrangement is not known, but the following official figures show that no remarkable increase has been made in the values of United States manufactures shipped to the countries involved:

	1889.	1893.
Agricultural implements	$ 127,331	$ 188,188
Machinery not otherwise specified	1,733,404	3,682,830
Railway-cars	410,905	615,757
Car-wheels	18,587	27,807
Railway iron	22,768	351,447
Steam-engines	308,349	1,028,947
Cutlery, saws, and tools	513,778	729,997
Firearms	393,258	227,844
Nails and spikes	140,746	212,846
Wire	298,772	684,310
Other iron products	178,359	363,256
Cotton goods	2,763,357	3,465,748
Leather goods	526,360	473,586
India-rubber goods	92,418	118,475

It probably would be found that the increase in any of the items in this table was not accompanied by a falling-off in European exports to the "reciprocity countries," but that it figured in the general increase in the commerce of those countries.

The secret of the success of England, France, and Germany in selling goods abroad has been in their study of the countries to be supplied and in establishing and maintaining close relations with them. This subject has been capably treated by Mr. E. L. Baker, the United States consul at Buenos Ayres, who reports * that there have been English houses doing business on the River Plate for upwards of a century. They have made such good use of their opportunities that the United Kingdom has control, in large part, of the Argentine trade. But there is also in Buenos Ayres a French colony of more than 20,000 people, all engaged in trade or business of some kind, and there are some 15,000 or 20,000 Germans, with a trade beginning to assume considerable proportions. At the same time, says Consul Baker, "there are not a hundred citizens of the United States in the entire country; and of these not twenty-five are engaged in American commercial business, and only one or two in the importation of American commercial goods." No sooner is any new want manifested by the people of the country than Europeans are ready with their offers,—

*Reports from Consuls of the United States, No. 163, April, 1894.

probably with goods in stock, or with European shipping facilities for ordering them speedily and European banking facilities for the handling of bills of exchange. There are no fewer than five British banks in Buenos Ayres alone. The position of the United States in many branches of South American trade is better illustrated by the case of a New York firm who received a cable order from Rio de Janeiro, and who answered that the goods could not be shipped before the return of a vessel which happened at the moment to be discharging cargo at the latter port. The Brazilian repeated his order by cable to London, and it would not be strange if he never attempted again to buy anything in the United States.

It is not here implied that there are not to-day in the United States manufacturers and merchants who are as enterprising and as successful in securing foreign trade as any of their competitors in Europe. There are firms which have laid the foundations of immense fortunes in the Spanish-American and Australian trade, particularly. Even in the Argentine figures there is encouragement, as will be seen from the following comparison (for 1892) of the share of leading nations in the commerce of that country, it being kept in mind how Americans are handicapped by the lack of ships, of banking connections, and of a resident American population:

Great Britain	$55,556,005
France	36,863,962
Germany	27,311,616
Belgium	21,319,265
United States	12,208,037

The independent, assertive, enterprising American character cannot fail to make its impress upon foreign commerce, just as it has succeeded in wresting the American markets from foreign control, when it is once fully understood that the route to new fields of trade does not lie through the halls of congress at Washington.

It is a mistake to assume that because England, for instance, leads in the export trade with any part of the world, it is useless for others to venture into the same field. As well might Americans once have hesitated to build locomotives or war-ships. Already American railway equipment has been sold readily in competition with the English in South America, while important outfits of our mining machinery have been ordered from Asia in preference to that of European production. Indeed, the whole question of competition with European manufacturers—apart from any question of superiority, one way or the other, of products—is one which offers encouragement to Americans. It must be considered that the United States, with an immense population of a high average purchasing-power, can continue to absorb greater

quantities of manufactured products than any European country in new developments—as in mining, bridge-work, electrical plant, etc. —and in improving existing railway equipment, rebuilding growing cities, and replenishing the machinery on farms, many of which sources of demand are better supplied in Europe than here. Consequently, our factories and their wage-earners are less dependent to-day than those of any other great manufacturing country on the export trade. The latter, instead of being their mainstay, is only a welcome addition to an already paying business. The factories, being maintained at a high grade of efficiency to supply an immense home demand, are in a good position for filling orders from abroad without the necessity for new equipment.

Our sale of surplus products, naturally, will be in newer and undeveloped countries rather than in the countries of Europe,—which began before we did to suffer from over-production,—except in patented specialties, which will sell purely on their merits, and such raw materials as cannot be bought elsewhere. It is not at their homes, but in common markets, that we must wage competition with Europeans. In this connection it might be of interest to study some of the international complications which Americans are apt to dismiss hastily as war rumors, due to the maintenance of big armies, but which often are the outgrowth of careful scheming to secure or retain markets, the loss of which might reduce the proud England of to-day to a second-rate power, as Spain and Portugal, former rulers of the seas, were reduced under like circumstances.

Mr. Holt S. Hallett contributes to the *Nineteenth Century** a notable article on "Western Nations and Eastern Markets," in which he asserts that the alliance between France and Russia, supposed to have been concluded last year, is as serious a menace to Great Britain's immense Indian empire and to her markets in the far east as it is to the peace of Europe. Napoleon and Alexander I, as early as 1807, sought by a league with Persia to drive England out of India. Long before that the French were suspected of having instigated the king of Siam to dismiss the English traders from Bangkok, and altogether the French have been recognized as active rivals of England in the east. The recent absorption by France of eastern Siam has enlarged her base for further aggression on Siam and China (which is one of England's most valuable markets), while India holds itself on the defensive for an advance of Russia. Russia has a wonderful power of assimilating Asiatics into subjects of the czar, and China regards with fear the progress of the trans-Siberian railway, which is being built avowedly for military and political rather than commercial uses at present.

* London, March, 1894.

France has also looked forward to the dismemberment of China, and to profiting thereby. Briefly, then, according to this writer, China, Japan, Siam, and England's Asian possessions—containing more than half the world's population, and the largest, richest, and most promising markets for English goods—are threatened by France and Russia to such an extent that British commercial intercourse with them will be crippled.

It must be understood that the British idea of developing these far eastern markets has involved extensive railway-building, since the seaboard and navigable rivers give access to only limited areas for commerce. Lines are now being pushed from the coast into the interior in all these countries, rendering them daily of more importance to England. India has become valuable as a market chiefly through the extension of its railway communication. The fears expressed by Mr. Hallett, that England's railway routes to India and China, existing or in prospect, may be blocked by the aggression of the rival great powers, lead him to a most pessimistic view of the future of British commerce, unless Her Majesty's government should succeed in protecting its eastern interests. One of his concluding paragraphs is significant: "If we lose our markets we lose our means of subsistence. With foreign competition hemming us in on every side: hostile tariffs barring us from our old markets: and *the knowledge that every bit of the world's surface which is not under the British flag or British protection is liable to be closed to our trade*, we are to do our utmost to safeguard and develop our commerce in the vast markets of the east." *

Whether or not Mr. Hallett's predictions may be well based, his views are shared by many others. Such considerations in part doubtless have prompted England to put under her protection as much as possible of Africa, with a view to developing future markets on that continent. If her commercial supremacy should be lost in eastern Asia—between which and the United States there is no barrier but the Pacific ocean—we ought to be in a position, having no political entanglements or rivalries, to make a strong bid for the trade of that part of the world.

For the present, however, the most promising field for extending the export trade of the United States is on American soil, in the countries to the south of us, in many of which undoubted development is taking place, in which peace and political stability are reasonably assured, and with which we are already on friendly terms. Every

* The italics in this paragraph are mine. The English writer, by the way, seeks to support his position by such facts as this: "Prices have fallen to such an extent that for twenty years the value of the yearly export of our [British] home produce has been practically stationary, and for the last few years actually decreasing, instead of steadily increasing in the same ratio as our population." H. H.

shipment of goods in that direction which has been made intelligently, and followed by intelligent effort, has served as an entering wedge for the introduction of North American products. There is a growing demand in the far south for such goods as our people are prepared to manufacture, while the products of that quarter are largely of a class which are needed here, and which do not compete with any of our home industries.

As for methods in the export trade, it may safely be taken for granted that what is being done successfully by one country can be done by another, just as Americans have demonstrated their ability to manufacture goods in any class that has been produced abroad. American disregard for precedent in dealing with political and industrial institutions, here on new soil and under novel conditions, may have been well enough, but in cultivating trade with other countries, perhaps much older than our own, it would be foolish to ignore the example of those who have already succeeded in this field, whether Americans or Europeans. To find what foreigners want, and for what they want it, and the differences between their tastes and those of our own country, is a work requiring study and application, involving travel and the special education of multitudes of our younger men. The manufacture of superior goods is not enough. Even low-priced goods will not give the key to the situation. The question, when our competitors are found selling goods in any market accessible to us, is "How is it done?" If our manufacturers are not ingenious enough to answer the question for themselves they may as well remain content with their home trade; no one is going to force the knowledge upon them.

ARCHITECTURAL EDUCATION FOR AMERICA.

III.—THE ENGLISH METHOD.

By R. W. Gibson.

WHAT is an architect? That part of the public which employs architects would describe him as a professional adviser and assistant in all matters pertaining to buildings—an executive officer whom they appoint to exercise authority and to perform duties of a practical, economic, and artistic nature.

Is this a correct definition? Or, is an architect a student of a traditional cult whose mission it is to engraft upon the outgrowth of a practical world as much as he can of his archæological flora, even at the sacrifice of his client's opinions and purse; and to maintain an academic standard and dogma, even if previous similar dogmas have been abandoned?

This latter definition is really the one toward which much academic training tends. It is quite naturally so. Schools must be conducted by men who devote more time to the traditional art than to the practical. They build up for themselves standards and precedents and methods out of touch with the greater world for which they primarily exist.

Art is a reality, and is greater and higher than her devotees have ever claimed. But she should be our familiar friend, visible in every work of every day, and therefore should descend to every-day matters. It is necessary that art in architecture should be ready and able for the opportunities which daily occur, rather than for the task of maintaining ideals of infrequent and debatable value.

The English system of architectural education, while it leaves much to be desired, has a great advantage in this regard. Its fundamental principle is that academic study shall be subordinated to, and coincident with, actual work under a practising architect. The student thus learns at one time the purpose and the profit of his studies. His wants, and the satisfaction of them, occur to him simultaneously.

There are possibilities in this system that have not yet been fully developed, partly because the academic course has even here maintained until recently too separate an attitude. Let us examine it in detail. The origin of the system is the apprenticeship, which sprang from the guilds in which all skill was organized in the middle ages. In Elizabethan times it was unlawful to follow any occupation without first

serving an apprenticeship. The articles of apprenticeship were not only a promise to teach, but also an admission to a close corporation, with its privileges to practise. But these restraining laws, after much curtailing, were finally repealed in the reign of George III, so that now the privileges are artificial or private, and largely fictitious. Still the form of apprenticeship survives for its other real advantages, and the architect in English practice who has not passed through it is rare. It is usual for a pupil to engage with a master for three years, paying a premium of about 200 guineas, part of which is returned as salary in the latter part of his term.

But the many branches of study which have no place in the office routine of an apprentice have to be provided for. These at first very appropriately fell to the care of those societies which had been constituted for the conservation of the higher interests of the profession. The Royal Institute of British Architects and the Royal Academy of Arts have long given some facilities to students in these departments, and, in a more general way, the National Art Training School (at South Kensington, with numerous branches) has assisted. The universities and colleges have also contributed in various courses towards the same ends, and more recently the new London county council has included technical education in its progressive programs. But with all of these independent and scattered opportunities it could hardly be claimed that there was a system until the Architectural Association, by patient, continued effort, established a real school of architecture in comprehensive form, and secured harmonious action with some of the other older societies.

This association, constituted in 1847, was, and is, one relying upon coöperative effort of the students themselves. More liberally inspired, more accessible, and more practical than the senior bodies, it speedily became more useful. Its early efforts, chiefly in freely-contributed papers and in classes for mutual criticism, reached a valuable efficiency twenty years ago; and lately have developed into a systematic four-years' course intended to supplement the training acquired in the offices where members are engaged as pupils or assistants. The fees are moderate—10 guineas each session—and the work is almost entirely arranged for evenings. The list of lecturers and instructors includes the most able men of the time, and the old system of honorary "visitors" (seniors as critics) is retained.

There are certificates, medals, and prizes, and beyond these the course leads up to that of the Royal Academy of Arts with its further lectures, medals, and scholarships, and to the examinations and graduation in the Royal Institute of British Architects, which is the legitimate "final" of any architectural training in England. The passing

of this examination, it is resolved, after 1894 shall be a preliminary condition to membership in the Institute. But apart from this fact the Institute examinations are really the natural sequel to the Association course, and, with the present cordial relationship between the two societies, they may be considered as forming a single system.

The curriculum at Kings College, London, spreads over three years a course of study also intended to lead up to the Institute examinations, arranged in three terms for the year, and occupying practically all the time of the student instead of only the evenings. It is claimed, however, that this work is intended to prepare students for admission to an office or to supplement their work there. But three years is a long time for the student in architecture to double by taking successively what he can do simultaneously. It is not surprising, therefore, that the Institute itself sustains, by quoting in its journal (October, 1892), the opinion that "the course of education now provided by the Association is substantially that most suited to the majority of students." It is gratifying too to note the following passage in the same place:

The constant aim of all Association endeavors is to develop originality and individuality in its members, and the fact that its government, and to a large extent its actual tuition, is in the hands of comparatively young men, is a complete safeguard against any tendency to rigidity or formality, in either its methods or its teaching.

A student of architecture in England has abundant opportunity for systematic work. After a good general education he may commence with the Institute "preliminary," by which he enters himself as a probationer, and a trial term in an office. Then (being articled probably, in deference to time-honored custom) he may enter the Association, and take up the curriculum as a four-years' course requiring four evenings a week for eight months of each year,—one evening at lecture, or class, one in preparation for the same, and two evenings in the studio. He may, of course, spread the work over a longer period, or perhaps shorten it somewhat. After two years he may pass the intermediate examination, the examination being divided in order to avoid the strain and "cramming" encouraged by one long-continued ordeal. After four years he may take the "final" or qualifying examination. All this time he has been at regular work as pupil or "improver" in an architect's office. He will then usually make a change to some other office in a more responsible position; perhaps he will continue his Association work; possibly it is not completed, or the examination not successfully passed. If he has still the energy and pluck for evening work he may enter the Royal Academy, of which the Architectural School is artistic only (omitting science as such). The course is valuable—the lectures, and the practice of more advanced design es-

pecially—but the greater number of students there have in mind the medals and scholarships. The principal prize is the gold medal and foreign traveling studentship, which, together, are awarded every second year. The course—probation, lower school, and upper school—takes five years. It would be very much better if this course could be brought into more harmonious working with the Association and Institute programs, so as to permit of its being taken by the same students without the excessive waste of time. At present it does not form a necessary part of the unified scheme, which may be called the English system of architectural education, and which may be summarized as first, the office work; second, the Association classes; and third, the R. I. B. A. examination.

The best results of the system above described are yet to be seen. The architecture of to-day is being done by men who enjoyed only the less perfect beginnings of the system, when it was building up by their experiences. There are great possibilities in it. It should turn out practical architects. It avoids, to some extent, that pitfall of youth, the self-satisfied period of collegiate graduation, from which the reaction upon entry into the real world is so demoralizing. It keeps the actual living work and the revered traditions in touch without allowing either to extinguish the other. It is above all others a practical system, having grown out of necessities, and not out of theories. To Americans it promises better results than any other, because of its coöperative, decentralized methods. The examining power is the only one claiming authority; all the educational routine is free for self-organization.

But the student should not be required to sink his whole individuality in the routine of a course. He will have his favorite special subjects, and should be allowed some time and opportunity for them, as well as for the ordinary social and intellectual pursuits of youth. The whole course of routine work should not necessarily exceed three years. It should be possible for the student to complete his collegiate education before entering the strictly technical course, and still complete the latter before that age at which it is necessary for a man to begin his individual career. Allowing a year for travel, and for the process of establishment, this would carry one to the age of twenty-four or twenty-five,—none too early for the commencement of a professional life.

While reducing the time demanded, further improvement might be made in the character and scope of the examinations. The tests should be more such as prevail in actual practice. A thoroughly competent man may—nay does—look upon a test of the usual kind with dislike and distrust, simply because of its pedantic and unreal demands. This should not be. All such examinations should represent as nearly as possible the conditions of actual work. It may be added that the standard

for graduation should not be so high as to be discouraging. If it is more difficult than the tests of actual work, it cannot be enforced. Conducted in such a way it seems that this system of standard examinations by a central body with authority, following a course of study under independent educating institutions in which variety may be permitted, is the most promising method of architectural education.

IV.—AN OUTSIDER'S VIEW.

By Barr Ferree.

ARCHITECTURAL education is the foundation of good architecture. The time when an untrained architect could make his mark in America, financially or artistically, has long since passed away. The question is not, "Shall the architect be educated?" but "How shall he be educated?"

First of all, the American architect must be trained with a view to his work in America. In itself this is a broader task than a single man can well hope to accomplish in a lifetime. The conditions of American life—the climate, the materials, the manner of living—are so varied and complex, and are so constantly changing and profiting by new inventions and devices, as to render the task of a busy practising architect a work of enormous complexity and magnitude. The wise architect leaves the details of this to skilled specialists, but he must be familiar with everything that enters into the construction of his buildings, and be entirely up with the latest methods. Most of this knowledge must come from self-training after the active duties of the professional career have been entered upon, but the preliminary studies must have all these complex circumstances in view or fail in the first elements of practicability.

For architecture is a practical art, and is concerned with the physical well-being of mankind. We may ornament our buildings with the richest flower of an artistic fancy, if we choose and if we can obtain a client who will pay for it, but at the bottom there is the fundamental fact that the building is to serve some useful end: it is to be used for some purpose, it is to have a definite, usable value. At the very beginning the architect's education must recognize this point. He does not enter the profession to create beautiful things on paper, to devise fanciful structures, or to make ornamental designs,—perhaps good enough in themselves but most unlikely of execution. His actual work, once he sits down to practise, is the designing of structures more or less utilitarian in purport, whose design is limited by countless

conditions of cost, of site, and of other elements that may not appear in the architectural text-books, but which strongly affect his work.

And from this there can be no mistaking the second point: that the architect's education must be conducted on a system that keeps the ultimate end well in view. Architectural training is a technical training, and under no circumstances should it be entered upon until the student has had the advantages of a thorough preliminary schooling. Being of this nature, it must have the student's life work in view. But it should do more than that. Not only are the final practical ends of the system to be maintained, but the student must have opportunities to gain a general knowledge of architectural history, forms, and methods which it is impossible to gain in the busy work of an office, and which, unless thoroughly grounded at the outset, may be forgotten in the turmoil and bustle of actual practice.

This is the vital point, and here, perhaps quicker than elsewhere, the advocates of special systems of architectural training will most widely differ. If, we are asked, the educational period is the only opportunity the architect will have to study the theory of his profession, should not his whole time be given up to such study, and the unavoidable practical work, which will come only too soon the moment an office is opened, be left for the future? As a matter of fact, architectural education is to provide that general technical training that cannot be obtained elsewhere. It would seem, therefore, on some grounds, eminently proper to give up this preliminary time to such study. But, in fact, the question is not so broad as this; the real question is not how much time shall be given to theoretical study, but what theory shall be studied, and how.

A theoretical study that ignores the practical application of the theory quite fails of the elementary purpose of training. This is especially true of architecture, which is entirely practical in its nature and expression. Theory should enter into the architect's education only in so far as it has a direct bearing upon practical problems. An education that stuffs a young man's head with theory, without showing him its application to his future work, is distinctly wanting in the practicability upon which all technical training should properly be based, and with which all his future work is concerned.

This brings me to another point, that the training of the American architect should be based upon American conditions. An architect may be filled with architectural theory without being able to apply it to the exacting conditions of American life. An education good for one land may not be good for another. Because an academic system answers sufficiently well, from the French standpoint, for France, it is a wholly unnecessary assumption that it will be equally suc-

cessful in America, which is most distinctly and unequivocally unacademic.

It is a pity that we have in America so few opportunities for the exercise of great artistic architectural talent. It is true we do not appear to have the talent to be exercised, but with more ample opportunities this might be righted. Architecture at any time and in any country is apt to be as good as the time and place can tolerate; certainly we can scarcely tolerate a higher grade of architecture than we have until the good of it and its value are appreciated by the general public, on whose patronage opportunities for good and bad work alike rest. Some day, perhaps, we may have an opportunity for producing the masterpieces that are the hope and dream of some architects. Meanwhile, it behooves us to do the best we can with what we have, to better it at every opportunity, to do all we can to hoist it out of the rut into which centuries of disuse have cast architecture. Little enough of what we have is inspiring,—so little and so unartistic that there is no wonder that those trained in a broad, theoretical field should look with regret upon early times of theoretical performances, and sigh over the disgusting little things that modern commercial necessities condemn one to practise with.

But that is what we have; why then try for something that cannot be obtained? The ideal modern American architect—I am not concerned with any other—is he who does the best with the opportunities given to him. American architecture, as no other architecture is or was, is dominated to-day by commercialism. It may be wrong that this is so, but it is an unquestioned fact. Any architectural training that ignores this hampers the young architect, and directly retards the bettering of American architecture, by providing an element of dissatisfaction with what is that is wholly uncalled for and is immediately harmful in its results. The American architect is called upon to solve certain conditions; his business is to solve them in the best way and usually with the least expense. Commercialism runs through his work, which is successful only so far as it fulfills commercial requirements into which artistic conditions enter only to a minimum extent.

Commercialism in architecture does not fit in well with theory in architectural education; yet in itself it is only the current form of the word "practical." Once in a lifetime an architect may be called upon to design a palatial residence or hotel, a museum or state house or other public structure, that calls for the exercise of the finest artistic talent; but if this happen more than once it is exceptional. The bulk of the work of the modern American architect is what may be termed "common things,"—strictly utilitarian structures with a maximum of se and a minimum of art. If these "common things" are to be im-

proved, if commercialism is to be rendered less commercial than the baldest treatment presupposes, we must begin at the beginning and train the architect with this end in view.

So far as I am aware, no system in America takes into account this phase of the question. Most of our architectural schools, as every one is aware, are modelled, in their strictly architectural teaching, upon the famous Ecole des Beaux-Arts of Paris. With many of the principles taught in this school every thoughtful architect must heartily agree, being in themselves not school principles at all, but the fundamental elements on which good architecture has rested in all times and in all lands. It is a remarkable fact that a school man will always talk better than he works. He will astonish you with the breadth of his training—broad, not so much for his sojourn in Paris as for his own personal application; he will amaze you by the correctness of his theory; he will dazzle you by the brilliancy of his knowledge; and then he will sit down and do the most preposterous things in design, simply because, with all his theory, his training, his brilliancy of thought, his power of expression, he has so wedded himself to certain forms and certain academic modes of expression as to be totally oblivious of their complete inapplicability to the necessities and exigencies of American architectural conditions.

How thoroughly this may be the case is well illustrated by the experience of one of the most promising and capable of the younger students at the Beaux-Arts. Prior to entering the French school he had been in practice in an American city, where he speedily won success by the readiness with which he solved the small average problems that come to every architect. After study at Paris he found himself quite unable to do what he had before done with so much ease and skill. Instead of small things he had learned to do great ones, and doubtless many years will be spent in endeavoring to secure the first large work that he has every reason to believe himself capable of doing. Personally, I should be glad to wish this gentleman the utmost success in the world, but his experience is most convincing evidence that the system of architectural education most in vogue in America is utterly at variance with the prevailing conditions and limitations of American life.

THE MT. WASHINGTON RAILROAD. THE PIONEER RACK INCLINE, COMPLETED IN 1869 BY SYLVESTER MARSH.

INCLINED RAILWAY SYSTEMS OF THE WORLD.

By Theodore C. Ives.

WHEN an obstruction is met with in the line of progress of any sort there are usually presented four alternatives: to go over, to go under or through, to get around, or to remain *in statu quo*, obstructed for all time. Nature has placed her obstacles to the progress of inland commerce in the form of the precipitous cliffs and massive undulations of the mountain-ranges which traverse the continents of the earth, and it is the various methods employed in overcoming these natural difficulties, according to the principle of the first alternative, "to go over," that this article will endeavor briefly to describe.

Primitive inland commerce grew and waxed strong on account of the facilities of interchange afforded by the many navigable streams, but was necessarily confined to their locality, and extended departures inland were always attended by great labor, risk, and loss of time. Hence, the growth of the river-towns and that wonderful fleet of steamers which once plied the waters of the Mississippi and its tributaries. Inland navigation was extended by the canal systems, but greatly restricted by sudden changes in the elevations of the country through which they were located, and a quick means of raising a boat from a lower to a higher level, that would obviate the tedious process of locking, became a necessity.

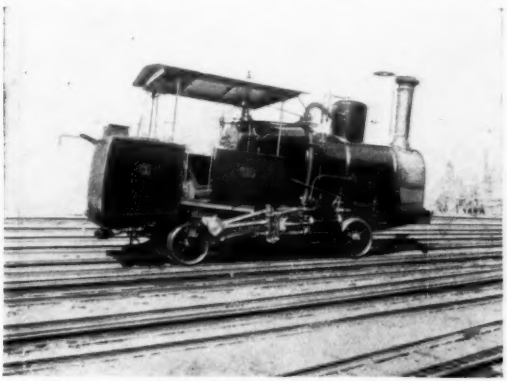
There are to be found to-day, on the old Morris and Essex canal, examples of the canal-boat inclines which at the time of their construction so greatly facilitated water transportation. A canal would seemingly terminate at the base of a hill, up which an inclined railway was constructed to the summit, where also terminated the canal of the upper level. The waters of the upper canal escaped through a sluice supported by a trestle which ran to the top of a tower constructed at the terminus of the lower canal; down this tower the water fell upon a water-wheel operating a winding drum; also at the end of the lower canal there was a great portable cradle on wheels. The boat to ascend entered this submerged cradle, and when all was secured, the water being admitted to the water wheel, the drum revolved, winding the chains or cables. Thus the cradle with its load would travel up the incline. Upon arriving at the summit the cradle was submerged in the upper canal, and, when liberated, the boat could sail calmly out of its curious carriage and proceed upon its way. With a boat going

THE VITZNAU-RIGI RACK ROAD, IN SWITZERLAND. TRAIN ASCENDING BRIDGE ABOVE THE TUNNEL.

ANOTHER VIEW OF THE VITZNAU-RIGI ROAD.

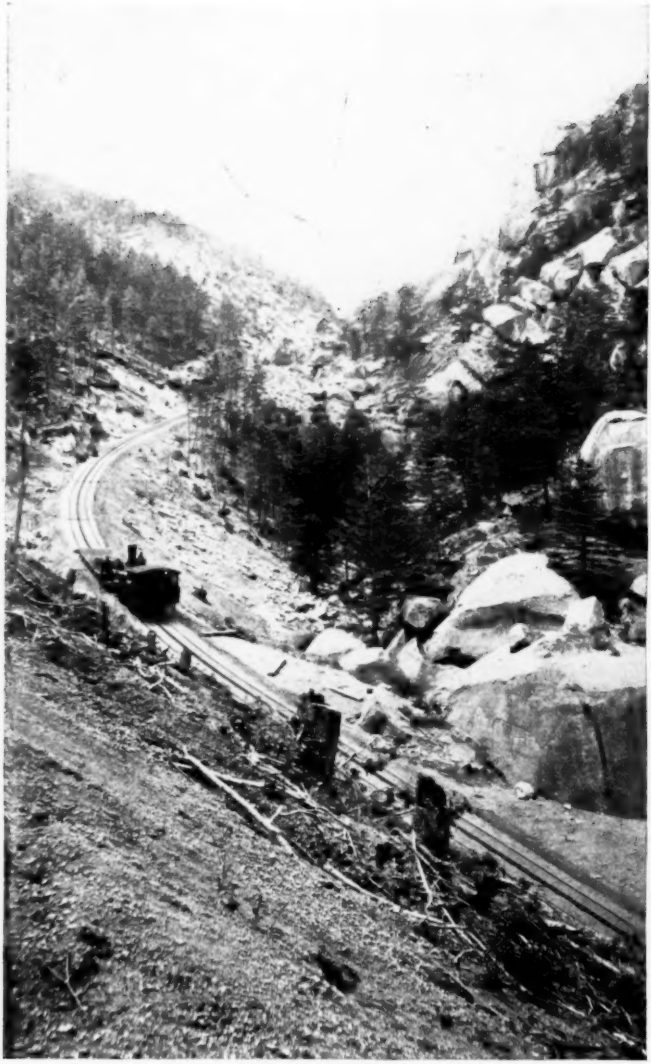
in the opposite direction this operation was reversed, and the boat, after entering the carriage and descending, could be safely floated into the canal of the lower level.

Sometimes the chains or cables would give way, and the resulting wreck of the cradle and canal-boat at the base of the incline would demonstrate the erratic flight in all directions possible to water when thus rudely disturbed.



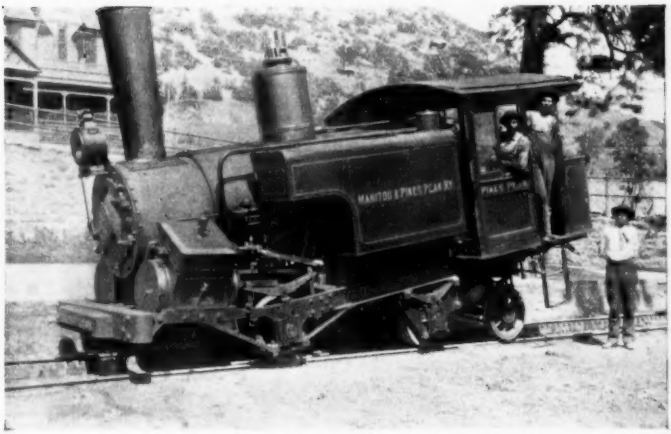
ENGINE USED ON THE RIGI ROAD.
[Locomotive with Horizontal Boiler.]

The introduction of the steam railroad made a revolution in inland traffic, but natural obstacles were found to be a great limitation to their location. The railroads seeking new country, and



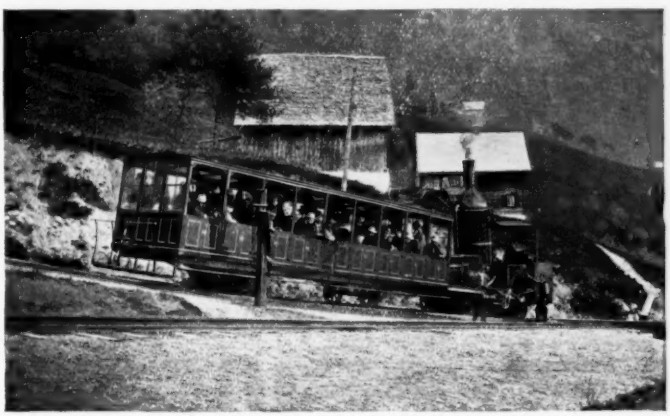
THE PIKE'S PEAK RAILROAD, ROCKY MOUNTAINS.

[Abt System Rack Road. Completed 1892. Maximum Grade, 25 per cent.]



ENGINE USED ON THE PIKE'S PEAK ROAD.

therefore departing from the populous banks of the large rivers, met hills to be climbed and soon demonstrated the impracticability of ascending more than very gentle inclines. The key to successful railroad location has always been in conforming to the natural drainage of a country, or, if departing from it, in passing as soon as possible from one system of drainage to another. At present on the great trunk-lines it is considered that the rise of one foot in a hundred should be the maximum for regular grades, any greater rise requiring assistant power



TRAIN ASCENDING THE RIGI ROAD.

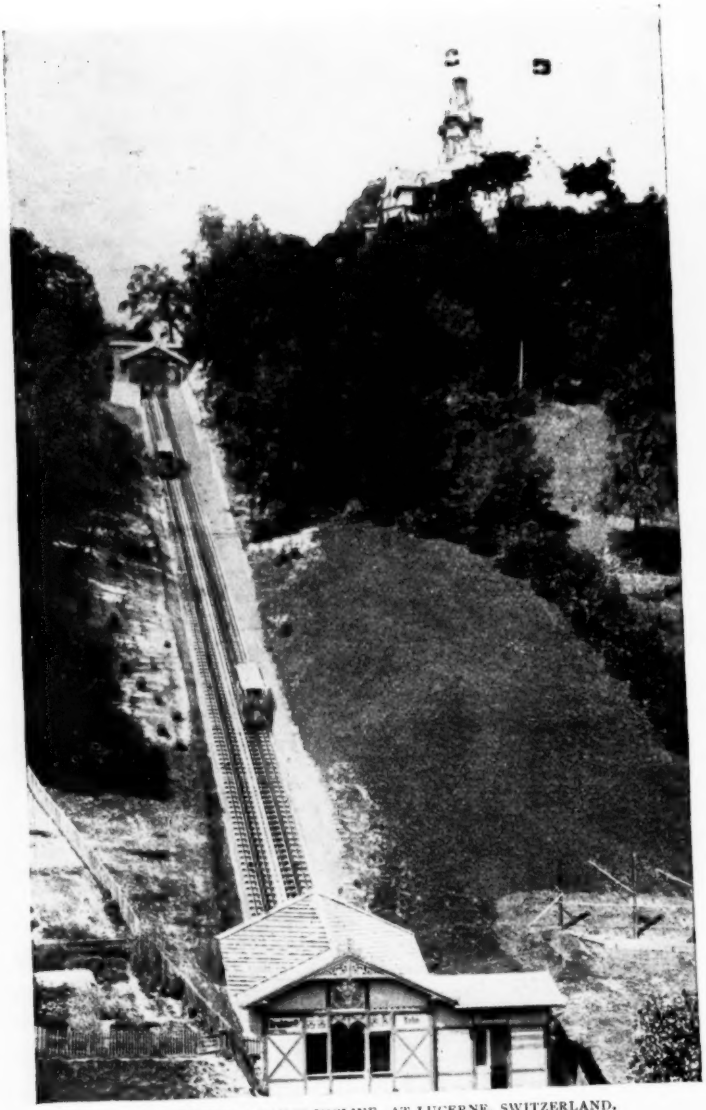
GLION CABLE WATER-BALANCE RAILWAY, SWITZERLAND.

[From Montreux to Glion, on Lake Lemon. Rise 997 feet. Maximum Grade 57 feet in 100.]

to move the maximum loads. Like the weakest link in a chain, the steepest grade on a railroad limits the carrying capacity. Though many roads operate grades of three and even four feet to the hundred, these relatively steep climbs are most uneconomical, involving extra expenditure in all departments of the service. Short railroads, with the burden of traffic mostly in the downward direction, and narrow-gage railroads, with light rolling-stock, operate even heavier grades, but at a serious disadvantage.

Therefore, to get over mountain-ranges, extraordinary developments have become necessary. Departing entirely from the direction of the objective point, a road is sometimes located in snake-like loops which turn along the hill-sides, up to the heads of ravines, the road coming almost back upon itself, all in order to make distance in which to "get up," without exceeding the maximum grade adopted as being practicable when considered in relation to the supposed future traffic. Remarkable examples of such development are to be seen in the numerous crossings of the Rocky mountains and the mountains of the Pacific slope, and a fine example is noticeable in the ascent of the Allegheny mountains by the Pennsylvania railroad from Altoona to

VIEW AT SUMMIT, RIGI ROAD, SHOWING LADDER RACK.



CABLE WATER-BALANCE INCLINE, AT LUCERNE, SWITZERLAND.

[Photograph Copyrighted by Loeffler, Tompkinsville, S. I.

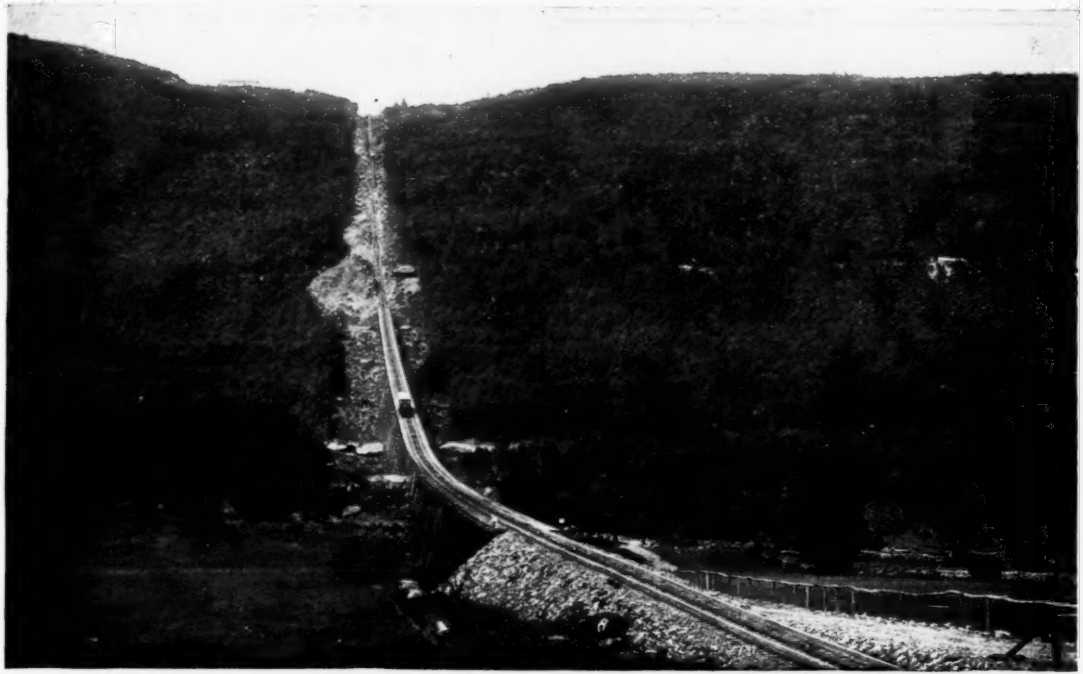
OTIS ELEVATING RAILWAY, CATSKILL MOUNTAINS.

[Showing Passing Point of Trains. Grade at this point 29 feet per 100.]

Cresson, around the famous "horse-shoe." The mountainous regions of Europe are threaded in a like interesting manner.

But the enormous expense entailed by the unproductive length of these roads and the time consumed in transit led eminent engineers many years ago to predict that, on account of the great advancement made in utilizing power, these great developments would be partially if not largely abandoned, and inclines with their increased directness and economy of time substituted. Prior to the adoption of these extended developments millions of money were expended in the endeavor to supplement the limited tractive power of locomotives by the use of cogged rails; also the supplying of auxiliary stationary power at points on the mountain railroad lines where steep grades seemed indispensable.

The old Portage road, crossing the Alleghenies and connecting the two canal systems east and west of those mountains, was a series of levels and inclined planes, steam winding-drums with ropes or chains supplying the power necessary to mount the heavy grades. This road was projected in 1829, and upon its subsequent completion became the overland connecting-link between the trade of the Mississippi val-



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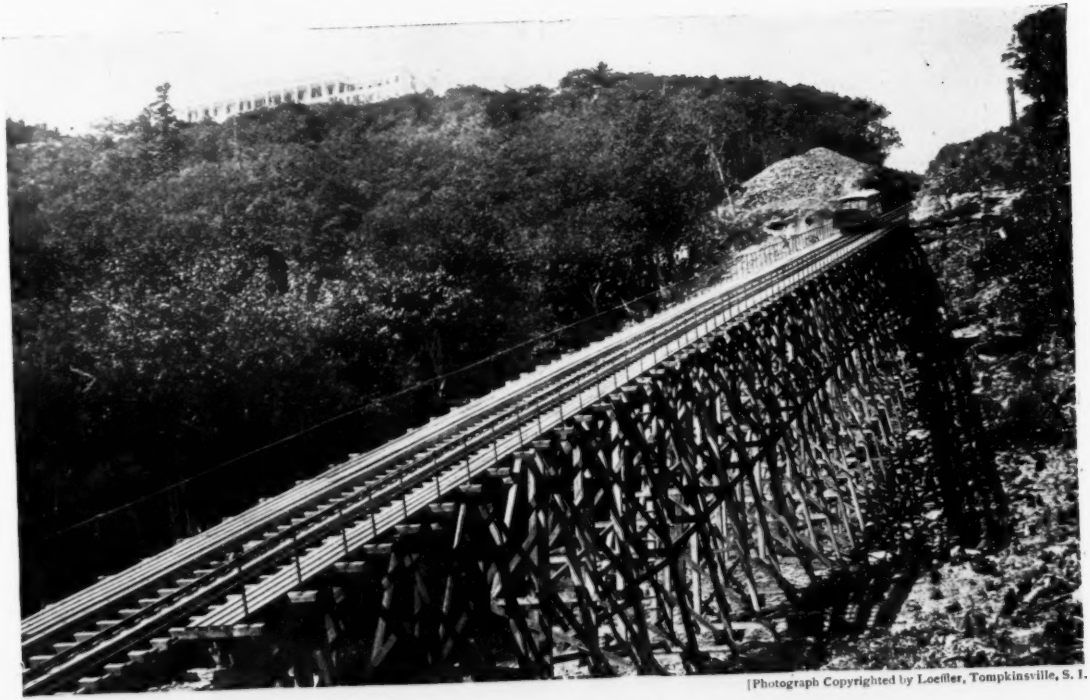
OTIS ELEVATING RAILWAY, CATSKILL MOUNTAINS, FROM LOWER TERMINUS.

[General View of Line Showing Compensating Curved Grade. Ris 1600 feet in 6780 Horizontal Length. Maximum Grade 35 feet per 100.]



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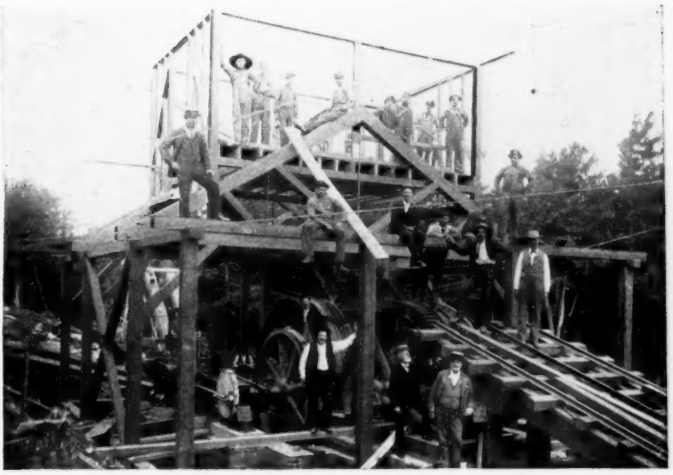
TRESTLE ON OTIS ELEVATING RAILWAY, CATSKILL MOUNTAINS, NEAR SUMMIT.

[Height 72 Feet. Old Mountain House in the Distance.]

A SPECIMEN DIFFICULTY IN MOUNTAIN RAILWAY CONSTRUCTION.

[Eighteen Thousand Pounds of Cable for the Otis Elevating Railway, Catskill Mountains, Ditched near a Precipice.]



OTIS ELEVATING RAILWAY, CATSKILL MOUNTAINS.
[View of Power-House at Upper Terminus. During Construction.]

ley and the Atlantic coast. This road was designed and located by the famous engineer Moncure Robinson, and was the great engineering feat of those days.

As long ago as 1812 a toothed rail was used in England on a road built and operated between Leeds and the Middleton coal-pits. This road was the invention of Blenkinsop, but improvements upon this system were of minor account until 1866, when Sylvester Marsh laid his locomotive ladder to the summit of Mount Washington, in New Hampshire. This ladder or center rail was made of two wrought-iron angles laid parallel midway between the main rails and connected by horizontal wrought-iron rounds.

Between these rounds the teeth of the pinion-wheel were inserted, and when the locomotive revolved the pinion the teeth caught each successive round of the ladder, thus producing the climbing action which overcame gravity on a maximum grade of 1 foot vertical to 2⅔ feet horizontal. This railway was completed in 1869, since which time, for a period of twenty-five years, it has safely conveyed thousands of tourists to the lofty summit of Mount Washington, without the loss of a single life.

European engineers were quick to learn of this great achievement and the rack system was much improved by them. The world-famed mountain region of Switzerland was soon to be invaded. In 1870

PASADENA ELECTRIC CABLE INCLINE, SIERRA MADRE RANGE, CALIFORNIA.

N. Riggenbach built the Vitznau-Rigi, which was followed some years later by the construction of the Arth-Rigi. Riggenbach did away with the round teeth and substituted trapezoidal teeth, with a system of involute gearing. Abt reduced the jar and disagreeable vibration due to the engaging of the pinion-teeth in the rack by using a double rack and double pinions, the teeth in one rack being approximately opposite the spaces in the other, thus obtaining a more constant pushing power. The Abt system, with its varying mechanical details, is generally acknowledged to be the most complete development of the rack road, and has been adopted throughout Europe.

Mt. Pilatis is a notable example, but in this case the locomotive has horizontal pinions which engage horizontal teeth projecting from both sides of the center rail. As the grade of the Mt. Pilatis road was necessarily about 48 feet to the hundred, it was feared that on account of this steepness the engagement of a vertical pinion with a rack having teeth perpendicular to the plane of the incline might be dangerous; hence the change of detail as described. In the Rocky mountains the Pike's Peak road was built on the Abt system and is successfully operated with a grade of 25 feet to the hundred.

The scope of this article does not admit of describing the many roads in the Alpine mountains and elsewhere, notably in South America,* that combine the ordinary traction system and the rack. In these cases the rack is placed between the rails only where the traction grade is exceeded, and at such points the engineer slackens speed, the pinion comes into action and his engine becomes a mountain-climber until, arriving at the next comparative level, he speeds away.

It is a significant fact that all these roads are used for the transportation of pleasure-seekers only, and seem to have led to no material progress in solving the great traffic problem on a commercial scale. Speed is unattainable and there are many other conditions of limitation. We are therefore led back to the old idea of a combination of traction grades with cable inclines, which of late years have undergone a great advancement in efficiency and economy.

The simplest form of the cable incline is the water-balance, and, when nature favors and provides an ample water-supply at an elevation equal to that of the upper terminus of the road, no other system can be employed with like economy. An old-time well, with a rope passing over a pulley with a bucket attached to each end—one bucket coming up as the other bucket goes down—illustrates the principle, except that in the case of the incline the water is at the top, and in going down raises the lower bucket by its descent. To the ends of a cable

* There is an important example of the combination system, constructed recently, at Rio de Janeiro, and another exists at Buenos Ayres.

passing around a sheave at the top of the incline two cars are attached, provided with water-tanks capable of being rapidly filled or discharged. The difference in the weight of the ascending and descending loads, together with friction, is all that has to be overcome. The upper car is made the heavier by filling its tanks with water; in its descent it raises the lower car and upon arriving at the bottom discharges its load of water preparatory to receiving its load of passengers and freight. The water required is only the amount necessary to augment the weight of the descending load so that it will overbalance the ascending load, the rapidity of motion being controlled by friction-brakes, either at the top of the machine or on the car.

When the upper live load is in excess no water is necessary, and only the regulation of the speed of the natural descent is required. To regulate this speed a rack is laid between the main rails similar to the rack of the steam roads, and a pinion-wheel in the car revolves upon it. A friction-brake on the pinion gives absolute control, which would even allow the car and load to make a safe descent with the cables detached.

The Glion railway from Montreux, in Switzerland, is a water-balance incline operated exactly upon the principle described. The rise is 997 feet, with the remarkably steep grade of 57 feet vertical to 100 feet horizontal, and the trip from the foot to the summit of the incline is made in seven minutes. The construction of the Glion railway is most thorough; the track is supported when not incut by arches of solid masonry, and about midway up it crosses, with a stone viaduct, the highway skirting the mountain-side. There are many smaller water-balance inclines in Switzerland. At Niagara, in America, a short one runs down the cliffs below the falls, on the Canadian side, to the whirlpool rapids.

In the Catskill mountains there is a striking natural opportunity to employ the same method. North and south mountains rise side by side on the eastern edge of the picturesque range, and nestling between these peaks is a pocket the elevation of which is about 2200 feet above the Hudson river or 1600 feet above the immediate main valley, while the summits of the two mountains rise on each side some 800 or 900 feet higher. The drainage naturally flows into the pocket and forms two pretty mountain lakes that discharge into the deep Kaaterskill gorge, running back and away from the eastern slope at this point. A simple ditch about 300 feet long, and with no greater depth than fifteen or twenty feet at the highest point, would divert the waters of these lakes and empty them directly over the face of the mountain into the valley of the Hudson; therefore the lakes form an ideal supply both in quantity and proximity for the operation of a water-balance incline of

immense proportions. In 1886 surveys were made and a line located by the writer of this paper with this end in view, but, though nature had furnished the water, the laws of the land gave proprietary rights to adjacent land-owners, who objected to its use, and thus the project was for a time abandoned. The incline finally completed at this point, two years ago, is now run by steam.

The great economy of the water-balance is apparent, but when the natural conditions do not favor it some other power than simple gravity must be employed; hence the use of grip-wheels or drums at the head of the incline driven by steam or electricity to move the cable upon the ends of which the cars are attached the same as in the case of the water-balance. This is also an economical method, as the descending load always lends the power of its gravity to aid in raising the ascending one. Inclines of this description are very numerous; generally three rails are laid, the center rail being used in common by both cars, and a turnout provided at the middle of the run to enable the cars to pass.

At Mount Vesuvius two inclines are operated, one a continuation of the other, their combined length along the run of varying grades being 10,500 feet. Mount Supurga, Italy, comes next with a length of 10,243 feet, with a rise of only 20 feet to the hundred. The road at Mount San Salvatore, Italy, rises 1973 feet in a run of 5358 feet, but is really two inclines each with one-half of this rise. At Burgenstock, Switzerland, the rise is 1444 feet, with a grade of 57 feet vertical to 100 feet horizontal. These are the great cable inclines of Europe, and there are many lesser ones. In most of these cases a rack is used with a pinion controlled by a friction-brake to guard against accident in case of the cables parting. In America there are also many small cable inclines: several in Pittsburgh and Cincinnati; one at Lookout mountain, with a rise of 1170 feet to a run of 4360 feet; and at Pasadena, California, there is an incline in connection with a general system of electric railways, where electricity is used to revolve the grip-wheels or drums. But the steam cable incline finally constructed at the Catskill mountains is the greatest in America, having a total rise of 1600 feet in a horizontal distance of 6780 feet.

There are some peculiar features in the construction of the Catskills incline which are worthy of comment, as they mark a decided advancement in this line of engineering work. This road was built in 1892 after the designs and under the direction of Mr. Thomas E. Brown, Jr. The first radical departure from old-time methods was in the adoption of a grade on a vertical curve so graduated as to result in compensation for the shifting of the great weight of the cables from one side of the road to the other, which, of

course, would occur at every trip. When starting the resistance to be overcome is not only the weight of the lower load, but also the entire weight of the cables,—and these wire ropes weigh 35,000 pounds. But as the lower load ascends this weight is constantly decreasing, for the cables, passing around the friction-drums, follow the descending load and add their weight to its gravity power. Consequently, in order that the engine shall only be called upon to exert a uniform power at all stages of the trip, and to perform the most economical work, the grade is made lightest at the bottom, but constantly increases with an upward curve in exact proportion as the weight of the cable is transferred from an upward resistance to a downward pull. It will thus be seen that the grade becomes steepest at the top, and by this compensation the shifting of the great weight of the cable is eliminated from the problem, the descending load always exerting the greatest gravity power at the time when there is the most to lift and its assistance most needed.

The Catskills incline also does away with the expensive rack and the pinion-wheel on the car for purposes of safety, and substitutes a clutch which is automatic in its action. A wooden stringer acting as a guard-rail is laid on the inside of each outer rail, this road having three rails with a center turnout as before described, and upon the top of this guard travels a friction-wheel attached to the car. Inside of this wheel are toothed weights that act like the governor-balls on a stationary steam-engine. If, due to any cause, as breakage of the cables or derangement of the machinery at the top of the incline, the car exceeds a safe velocity, the governor-weights fly out, and, throwing in the clutch on the wooden guard-rail, the car is brought to a stop.

Many other new devices have been employed in the construction of this road tending to the safety and convenience of traffic. But, more than this, the Catskills incline has demonstrated an economy far greater than previously attained by any of the steam cable inclines of the world.

There are many circumstances that arise during the construction of inclines which make such work somewhat different from ordinary railroad construction; materials of all kind develop a wonderful facility of getting away, and every man is more or less in jeopardy from possible carelessness on the part of any of his fellow-workmen above him. In ordinary work, if a rail slips the tongues it remains to be picked up again. Not so on the incline where mishandled material starts on a wild course of destruction toward the foot of the mountain. Careful provision must be made for anchoring the whole roadbed to prevent a general slide.

The substantial method in Europe of using solid masonry to this end is of course the best. But it has been proved, by the many successful structures of wood and iron in the United States, that such a large first cost is not imperative.

In conclusion, is not the engineer justified, by such advancement and improvement in economy, in speculating upon the future of the incline and the possibility of its substitution in many cases for the long and uneconomical railroad developments in mountainous country now so universally adopted? It must be admitted that where traffic is very intermittent the day has not yet arrived when the incline could be economically applied, but where traffic is almost continuous in both directions, as in the case of the Pennsylvania railroad at Altoona, why should not the wasted gravity force developed in trains passing from the summit to the valley be utilized in the assistance of trains climbing from the valley to the summit? Trains could run upon inclines as they now run upon transportation barges, and, after the few minutes consumed in ascent or descent, shoot away on the levels at their mile-a-minute speed, thus saving hours of time and seemingly endless miles of circuitous construction.

GOLD AND SILVER IN SOUTH AMERICA.

By Arthur L. Pearse, M. Am. Inst. M. E., M. I. M. E.

THE modern world has not been as much interested at any other time as it is now in the quantity of precious metals produced and in the outlook for future production. Formerly the question was one that interested chiefly adventurers, mine-owners, and speculators, the great mass of people not being concerned about a matter that did not appear to touch them nearly. But now the monetary discussions in all the great nations of the world and the radical changes of legislation have taught everybody that no question comes closer to individuals than the monetary question; that no influence is more potent for the making or undoing of private prosperity; and that no power is stronger for the welfare or the injury of the state.

The specific question now is: whether the fall in the price of silver is going to diminish materially the production of the white metal, and whether the appreciation of gold will increase the output of the yellow metal. It is to contribute some material towards an intelligent answer to these two highly-important questions that I have, at the request of the editor of the Magazine, prepared this paper. I have spent many years in South America, having left only within the past few months, so that my experience will probably be held as a sufficient justification for writing. It is intended to take up the various countries *seriatim*, to point out as comprehensively as space will permit the existing conditions, and to forecast as carefully as may be the future.

CHILE.

Let us begin on the west, following the coast around in the geographical order of the countries. Chile at present contributes to the metallic stocks of the world about equal values of gold and silver; the gold output being about $1,500,000 and the silver-production averaging about 3,000,000 ounces. Its output of the more valuable metal has been fairly constant for 350 years, as we know from scrupulously-kept ancient Spanish records. It reached a maximum gold-production of $2,000,000 in 1888, through the profitable workings in that year of the Guanaco gold-fields. This deposit is still worked extensively, but the results of late years have been disappointing.

The alluvial and placer deposits of the country have all been worked out by the Indians; all mining is now in quartz. The principal gold-centers are in the departments of Rancagya, Aconcagua, Coquimbo, and Atacama. In the latter department is Taltal, where a number of mines are worked on a small scale, and where a large num-

ber of "beneficiating" (reduction) establishments have been started. These buy the ores in small quantities from small miners, thus permitting production to proceed with limited capital and plant. Until lately Chilean ores have been held hard to work and difficult of amalgamation. The high percentage of loss in reducing was attributable, however, more to the fineness of the particles in the gangue than to any initial refractoriness in the ore. Of late improvements in methods have had a most satisfactory result in largely increasing the percentage of metal saved, notably at the Atacama works at Taltal, where works are also in course of erection for the beneficiating of ores by means of the cyanide process.

A considerable amount of the Chilean ore is of extremely high grade, and the custom still obtains of shipping such ores to Europe for reduction. The results justify the enormous freight-charges when the ore runs from 10 to 15 ounces of gold, which is often the case. I once saw a picked three-ton lot of Guanaco ore running 600 ounces of gold to the ton. In the southern parts several small concerns are working and extracting gold, and there are most promising prospects in the Copiapo district. The mines there have all the elements of success, but the natives lack the energy to develop their resources as rapidly as would be done in the United States.

Chile reached its maximum of silver-production in 1886, when the output was 8,725,000 ounces. The increase was accounted for by the discoveries at the Caracoles mines, which have since failed. The Chilean silver-ores are notably easy of working, as the metal is found either native, as a chlorid, or an iodide. Silver can therefore be produced cheaper in Chile than in the more northern countries—Peru, for instance—where the ore is more refractory. The oldest silver-mines in the country, which are still producing, are near Iquique, at Huantajaya, and in the district of Cachinal. They present the curious condition that the metal is found in the lode in great pockets, so that, from time to time, large quantities of rich ore are found.

A prejudice exists against Chilean mining. People think, because some lodes near the coast have turned out to be gash veins, and because some of the promising mines, such as the Guanaco, have proved to be "blow outs," with only superficial and early exhausted deposits, that there is no prospect for deep-mining. They forget that copper lodes have been followed down at several mines in Chile for 500 meters, and that there is geological reason for supposing that the true gold lode should be equally constant in depth. It seems obvious that the mineral resources of the country are by no means beginning to be exhausted, and that Chile has before it many generations during which it will contribute to the mineral wealth of the world. Vast districts, especially

near the desert of Atacama, are still open to the prospector, and lodes of silver, copper, and gold are constantly being discovered. There is no doubt that a great number of good mines yet remain to be found. It is not many years since some of the most successful mines were located, the Caracoles, the Arturo Pratt and several of the best mines in the Guanaco district; many people are still constantly engaged in looking for gold and silver, and in developing new interests.

The influx of capital is encouraged by laws highly favorable to the mining interest, founded on the old Spanish code. The taxes amount to only ten pesos ($3 in gold) per annum for each *pertenencia* (claim), and, if they are not paid when due, there is a concession of considerable time during which the delinquent does not lose title. There are also provisions against the seizure of mines for debt. Yet capital is timid about investment in Chile. The crash that followed the over-development of the Argentine and the revolutions that have, like the measles, run their course from one South American state to another have prejudiced the moneyed interests of the United States and of Europe against all investments in the southern continent; and it is likely to be some years before mining capital will flow freely into Chile. Those who have had the pluck to go in there with money have been handsomely repaid. War and revolution have not materially affected their interests. The labor of the country is the best in South America. The native Chilano is hardy, intelligent, and an intuitive miner. His wages are paid in paper pesos now worth say 30 cents, or 15 pence. Three of these paper pesos is an average day's wages.

It will be gathered from the foregoing that the diverging values of the precious metals will not have much effect upon the mineral industries of Chile. The fact that the currency of the country is a debased paper currency stimulates production and helps the export of silver. Some mines that have been struggling on for some time just paying, or not paying, will probably shut down; while others will increase their output capital and energy will naturally turn to the development of gold rather than of silver interests.

BOLIVIA.

Bolivia has been benefited in reputation by being in the interior and difficult of access; distance has lent enchantment to the view. The most exaggerated stories are in circulation relative to its mineral wealth, and thousands of practical miners believe that vast riches are hidden in the interior. In my own judgment, the country as a whole is vastly overrated, the major part of its production coming from a few centers. It has in fact almost ceased to be a gold-producing country, its output in 1891 having amounted only to $67,000. Its gold produced is, however, subject to such variations as are all placer-mining countries, and

rich discoveries in limited areas sent its out-turn in 1871 up to the maximum in three centuries, namely, $1,500,000.

There are few white people engaged in mining, owing to the small temptations of the limited return and the hardships and isolation necessary to be endured. There are a few adventurous prospectors traversing the country, but the results of their arduous endeavors have not been such as to encourage others to follow their example. Lately, however, an organized investigation of certain parts has been going on with more of system than has before been attained. It seems that a New York syndicate are exploring the Beni-river country primarily for india-rubber, and that they are also prospecting for gold.

The small amount of gold now produced is panned out by the native Indians, with the crudest sort of appliances; but the placers are practically exhausted. Such examination as I have been able to give to the placers and gold-ores of the country convinces me that they are largely of low grade, and of nothing like the average value generally represented. Bolivia is, however, a large producer of silver, its out-turn running about $15,500,000 annually, half of which comes from one mine. It is an interesting evidence of the strength of its silver resources to recall that the product of the country in 1550 was $7,500,000. The considerable yearly output comes from a few large mines which yield generously, and it is certain that the output of these mines must be stimulated by the low price of silver. The metal is like the product of a textile factory—if the goods fall the manufacturer must sell more. At the Huanchaca mine, the output of which last year was $8,500,000, they have spent over $1,000,000 in a reduction-plant at Antofagasta, the seaport, the object being to reduce the ores heretofore of too low grade to pay for working on a smaller scale. The railway from Antofagasta to Oruro was completed a few months ago, and a new country will be opened up of several hundred square miles. But there is no apparent likelihood of any considerable increase in the gold-production.

Some of the smaller silver-mines that have been shut down would undoubtedly be running if silver were ten or fifteen cents higher in price; but against this must be reckoned the increased output of the larger concerns. The principal silver-producing centers of production are Huanchaca, Cerro de Potosi, Colquechaca, Oruro, and Aullagas. There is also a large and possibly productive tract containing gold placers in the eastern and northern parts of the country, of which comparatively little is known. The probabilities are that this tract, which adjoins and is geologically identical with the Peruvian provinces of Sandia and Carabaya, is neither better nor worse than these districts, which I will mention in connection with Peru.

PERU.

The ancient records show a large output of the precious metals from Peru, but it is probable that a great part, if not the chief part, came from what are now known as Ecuador, Bolivia, and north Chile. The present gold-production is only about $75,000 per annum, of which $50,000 comes from one mine in the Sandia district. This and Carabay are auriferous districts of vast extent over the Andes, adjoining Bolivia and among the head-waters of the Amazon, but they have been uniformly overrated. No doubt some of the placers are fairly good, but the best of them are at so high an altitude that no adequate supply of water can be brought to bear, and in consequence production is limited. The Sandia deposit is probably the largest bank of auriferous gravel in the world. It is the only bank in Peru ever equipped with modern hydraulic appliances. Its present return of $50,000 per year might easily be quadrupled. Other gold-fields are those of Pallasca and Pataz. The difficulties of distance and height must always prevent the adequate development of many otherwise promising lodes and placer deposits. Although there is still a field in Peru for the prospector, I believe that only one organized prospecting party is now traversing the country. Nearly all of the gold produced outside of Sandia is washed out by Indians with wooden pans.

A number of well-formed lodes have been discovered in the Pallasca district, and only await the coming of capital for adequate and, I think, remunerative development. This district is in the second range of the cordilleras, 7000 feet above sea-level, in a region of perpetual spring, but it is 100 miles from the nearest railroad. The specimens that have come to hand from a lately-discovered district behind the port of Chala, and the reports of a few competent judges who have been over the ground, indicate that exploration might prove this to be a gold country of exceptional richness. All through the country are small locations which might be worked at a profit elsewhere than in Peru, but the natives will not take the trouble to develop them.

Peru ranks next to Bolivia in the production of silver. In 1533 its yield was $1,250,000; in 1800 it was $6,250,000; and the present rate is a trifle over $3,000,000 per year. Its most famous mine and its largest total producer is the "Cerro de Pasco," which contains large bodies of oxidized silver-ores, easily accessible, but of low grade. It has been worked a century, but unless a large amount of capital is expended on it for deep drainage it has probably seen its best days. The silver-production is fairly well divided between four or five centers. The largest present producer is the Callyoma mine, the output of which finds its way abroad over the Southern railroad to Mollendo, which is also the outlet for much of the Bolivian ore. The

bulk of the silver-ore is refractory, and the country is inadequately supplied with reduction-works. The practice is to ship selected high-grade ores to Europe for reduction.

There are large bodies of low-grade silver-ores in many parts of the country, notably in the Callyoma district and at Carahuacra. Some day these bodies will no doubt be adequately and systematically worked, but the present low value of silver will have a great influence in retarding development. The height above sea-level at which most of these bodies lie is phenomenal, and this no doubt constitutes a serious obstacle, particularly in the high cost of preliminary equipment. Such equipment in Peru will cost fully 100 per cent. more than in most countries. For years it has been supposed that smelting operations could not be carried on at all at great heights; but it has now been practically demonstrated that no real difficulties exist. The largest smelting-works of their kind in the country are those in successful operation at Casa Palca, 13,600 feet above sea-level.

Native labor is inexpensive, but requires constant and costly supervision. There is no gold or paper currency, and the monetary standard is the silver Peruvian dollar, or sol, weighing 25 grams of 900 fine. The mint at Lima is one of the finest in the world, and its coins are accepted as standard elsewhere in South America and in Europe. The basis of the mining-laws is the old Spanish code. Mines are subject to a small semi-annual tax of 10 sols (say $5 in gold). The laws are fairly administered, as a rule, but if the tax is not paid the day it is due the mine is subject to denouncement.

COLOMBIA.

Colombia, the El Dorado of the old Spaniards, has produced more gold than any other country of the southern continent, the total yield from its alluvial deposits being estimated to have reached $500,000,000. Its annual production, for many years, has varied little from about $1,250,000. It has not been a producer of silver until within late years, but some silver-mines are now being worked, of which the best known are those at Tolima. The total annual output of the white metal will not, however, reach $1,000,000 in value. The principal mining centers are in Antioquia and Cauca (including Choco), and in Panama and Tolima. The two first named are from 4000 to 5000 feet above sea-level, and have an excellent climate.

Antioquia is peopled chiefly by the descendants of Jews who fled from Spain in the time of Ferdinand and Isabella. They are thrifty and industrious and maintain a gold currency, whereas the other states of Colombia are on a silver basis. The province of Panama contains much gold; there is probably no river within its borders from which gold could not be panned. The riches of the Darien are historical

and the mines of Cana, according to the authentic records of Panama, have produced some $80,000,000 in gold. The most promising part of this department is in the country of the Chucanaque Indians, between the Darien and Atrato rivers. This district has not been much explored, as its riches are protected by a dense tropical growth and by several thousand war-like and unconquered Indians. Large amounts of gold and india-rubber are traded by these Indians out through the San Blas country, and there is reason to believe, from the amount and nature of the gold, that there are rich alluvial deposits as well as powerful lodes. That this country will be opened up in this generation is improbable, but it is certain some time to contribute a material addition to the world's stock of gold.

There are good placers still untouched in the Cauca district, and between Cauca and the Pacific. The country is so densely covered with tropical vegetation, however, that prospecting is almost impossible. In other departments of the interior there is an admirable field for mining without the difficulty attendant upon operations in the more tropical parts. The output of the country can hardly fail to increase in the near future, as gold is universal, and modern methods of extraction are gradually being introduced. Access to the interior takes time, but it is not difficult. The main artery, the Magdalena river, is navigated by sternwheel flat-bottom boats for five days, to the head of navigation, whence supplies and machinery must be conveyed by small local railways, by vehicles, or by pack-animals, according to their destination. On the whole goods can be conveyed more cheaply than in many parts of Chile or Peru. The mining-laws are equitable.

ECUADOR.

The present gold-production of Ecuador is merely nominal, but preparations have been made to develop the placers known as Playa del Oro, on the borders of Colombia. An American company with large capital has gone in there with an extensive plant, and if only a small percentage of their highly-sanguine expectations is realized the result must be a material addition to the resources of the country. There is a great field for prospectors here, and doubtless a great deal of mineral wealth, but the difficulty of coping with the tropical vegetation and with the Indians,—one of the tribes, the Jibarra, being cannibals,—renders the development very slow. It is reported that good gold lodes exist in the interior, but nothing of importance has been done with them. One English company—the "Zuruma"—has been operating for some time, making gold shipments of $120,000 a year. Ecuador yields no silver, although its currency is of that metal.

VENEZUELA.

This country has produced a large quantity of gold within thirty

years past, but the present decade has witnessed so serious a falling-off as to create fears that its richer deposits are becoming exhausted. Its output of metal has been nearly all taken from the district of Caratal, of which Cuidad Bolivar is the principal town. The district is reached from Trinidad by steamer up the Orinoco, and afterwards by a three-days' journey on mules. The cost of transportation is very great and only the richness of these mines would have justified the expenditure. Here is situated the famous El Callao mine, the greatest producer in its time that the world has seen. In close company are the Callao Bis, the Chile, La Union, etc., and many smaller mines and great numbers of prospects. The gold-production has fallen from $4,000,000 to $6,000,000, in 1886, to a little more than $1,000,000. Notwithstanding this considerable and progressive fall of output, it does not seem to me that the retrogression is likely to continue, and I look for an improvement.

The present prospects of the El Callao Company are better than they have been for years, and of late a considerable advantage has occurred in the cheapening of labor. There are other mines in the vicinity, especially the Chile, which should materially increase their output in the near future, with better processes and better management. All through the mountains of the country gold is to be found, but not yet in such quantities as to encourage the investment of foreign capital. The Caratal district has been fairly well prospected, but the rest of the spur of the Andes running east and west through the country offers a highly favorable field to the gold-prospector.

There is little silver-mining. The deposit of argentiferous galena near Carupano has been of some importance in the past, but the fall in value of lead and silver has resulted in the practical closing of the mines. The currency of the country is gold. The mining-laws are generally the same as elsewhere in South America, except that prospectors may secure title to larger areas than in the other states.

THE GUIANAS.

British Guiana, of which Georgetown is the capital, is the only colony that Great Britain has in South America. Low, alluvial plains extend some forty to seventy miles back from the coast. Beyond rises an eastern spur of the Andes, containing metalliferous rock. This mineral district is no doubt a continuation of that rich region of Venezuela that contains the famous mines of the Ciudad Bolivar district. Here lies the disputed land claimed by both countries, which produces from 8000 to 10,000 ounces of gold per annum, which is shipped through Georgetown, going to swell the nominal output of Guiana. The mineral wealth of British Guiana has been little developed, owing to the distance of the mines from any base; to the difficulty of trans-

portation ; to the malarial climate ; and to the slight attention that the colony, comparatively speaking, has attracted to itself as a gold-producer. At present there exists only placer-mining, whereas there is reason to believe that the real metallic wealth of the country lies in the mother lodes from which the gravel has been denuded. Prospectors have gone carefully through the country for years, and only last year some highly-valuable locations were made far in the interior, which promise to increase materially the output of the colony. The only method of working at present in use is hand-sluicing, the flatness of the country not lending itself to the hydraulic methods of California, where large quantities and high heads of water can be brought to bear upon the banks. Hence, in order to pay, the gravel must be of a high grade.

The people of Georgetown, who watch with a keen interest the development of their gold resources and who contribute to the development by investment of their money, are talking about a railway from the head of navigation on the Essequibo river to the principal center of the gold-washings, but its early construction is not probable. Meanwhile all communication is by boats propelled by the native Indians, who are peaceable but indolent. The negroes are the laborers and miners. Contracts are made with them in Georgetown, whence they are transported to the mines by boats, together with their provisions. There is considerable illicit traffic in gold at Georgetown, with the blacks, and as much money has perhaps been made by individuals in this underhand commerce as has been made by legitimate adventurers.

It is quite evident that, under all these adverse circumstances, the progress of the gold interests of British Guiana must be slow. But that the colony has before it a great future as a gold-producer I have no doubt, provided that the disputed country above mentioned is ultimately found to belong to Guiana. It is, in my judgment, this district that contains the bulk of the future riches. The colony thus far has attracted little outside capital to the development of its metalliferous resources, the Georgetown people having supplied the money, but so promising a field will not long be neglected. Some valuable information I give here as to the cost of production of gold is in the form of a quotation from a letter from the chief of a prospecting party which explored the country a year ago :

> These fields produce, in round figures, 110,000 ounces of gold per annum, of an average value of $17.50, to produce which about 10,000 men are employed at an average cost of $1.15 per day, exclusive of tools and transportation. It therefore costs $3,450,000 to produce less than $2,000,000. With the exception of one or two places, the gold is found in small patches which will not pay for the stripping, as one has usually to move from six to ten feet of waste ground to get one foot of pay gravel, and never more than 2½ feet. There is no chance for anything like hydraulic mining, and all ground worked at a profit must, from the nature of the country, be very rich. As

I have shown above, there is a great loss which must continue to increase as the nearer reaches are worked out and we have to go back towards Venezuela, which seems to me to be the principal source from which comes all the gold of this country.

In Dutch and French Guiana the same geological conditions obtain as in the British colony, and such surface deposits as have been worked have been developed by the slow and costly process of ground-sluicing. Considerable money has been invested in the mining industry in the two colonies, but each dollar's worth of gold extracted has cost double its value. The yearly output of Dutch Guiana runs from $500,000 to $750,000, while the French colony, in 1892, produced metal to the value of $800,000. In the latter place there has been considerable lode-mining, from which there have been good results, though the bulk of the yield has been taken from the placers. The effect of this has been to encourage the investment of French capital, and attempts on a considerable scale are being made to develop the lode-mining. It is not probable, however, that the contributions of any of the three Guianas to the world's stock of gold will ever reach a considerable volume. There is no silver in any of them.

BRAZIL.

The annual production of gold in Brazil is less than $500,000, having fallen off gradually since 1750, when the maximum output of $9,000,000 was recorded. All accessible placer-mines and surface lodes have long since been exhausted, and the geological features of the less-known interior are not such as to encourage hopes of the discovery of any rich deposits. At a distance of 3000 miles from the coast the surface is barely a thousand feet in the mean above sea level, and the land is covered with impenetrable jungle. The country as a whole presents less attraction for the adventurous prospector than any other South American state, and it is not probable that the present output will soon be materially increased. There is some deep lode-mining, in the well-known mines of San Juan del Rey and the Ouro Perto.

The proprietors of the former mine are now devoting attention to development work, thereby reducing for the time their output; the result of this work will probably be to restore the mine to its former position as a large producer, and it is likely to revive the glories of its name. Its main shaft is down 1100 feet, and its history has been remarkable for its continuity in depth. It is one of the deepest mines in South America, and its record is encouraging to many who, like myself, believe that the development of scientific deep mining in the country will give satisfactory results.

Most of the gold-ores of Brazil contain some silver, the proportion sometimes running as high as 20 per cent.; otherwise the production of silver is practically *nil*. The mining-laws differ little from those of

surrounding countries. What is known as the "side-line" law obtains there, and mines are denounced and held under small annual payments. There is a plentiful supply of native and black labor, very good, and not expensive.

ARGENTINE.

That there is gold in Argentine is certain, but the attention of the people has been devoted almost entirely to agriculture and grazing, and it is difficult to forecast the development of mining. Some small placers in the southern part have been satisfactorily worked, and from time to time exaggerated reports of great discoveries reach the outside world. Lately a government official has been appointed to investigate the report that gold exists in paying quantities along the eastern slopes of the Andes. There is every reason, geologically speaking, to expect that Argentine will one day be a considerable producer of gold. Since the eastern half of Patagonia has been added to the country the mineral resources of the peninsula have attracted considerable attention, and auriferous sand in considerable quantities and quartz specimens rich in gold have been brought to Buenos Ayres and shipped to Europe. The character of these specimens indicate the presence in Patagonia of fairly powerful lodes. There is a small silver-mining industry along the foothills of the Andes.

It will complete the review of all the South American countries to say that Paraguay has practically no precious metals and that Uraguay has a few deposits of low-grade ore. The richest rock the country has produced mills under $5 to the ton, and the annual production of gold is about $7500.

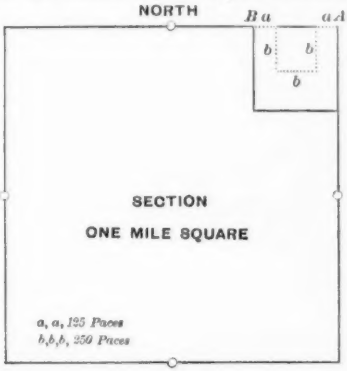
From this necessarily brief summary it will be seen that the total production of gold in South America is considerably less than $10,000,000 per annum,—less than a third as much as the output of South Africa. It will also be apparent that, except in certain inaccessible districts of Colombia and at the headwaters of the Amazon, surface deposits have practically been exhausted. New placer discoveries or alluvial deposits great in extent and rich in value are quite unlikely to be found; and the future of the gold industry depends upon patient, laborious, and scientific lode-mining with modern methods and machinery. The silver-product of the continent is something over $20,000,000 in value. Of this three-fourths come from Bolivia and more than one-third from one mine (the Huanchaca). It is unlikely, under existing conditions of production, that the low price of silver will have any material influence in reducing the output. The loss from such struggling mines as shut down and cease to contribute to the product will be offset by the increased production from the larger mines, which will be stimulated to a larger output to compensate for low prices.

THE NORTHERN WHITE-PINE INDUSTRY.

By Richard A. Parker, C. E.

FEW visitors to the World's Fair failed to be attracted by the novel exhibit made there of a Michigan logging-camp, including the enormous load of logs piled upon one sled. Many supposed the display to have been made wholly for advertising purposes, not thinking that what was there shown could be in any way typical of real life in the pine-forests. It must be admitted that the log-cabin was finished somewhat better than is common, and that the load of logs exhibited was larger than is usually hauled; but the elements of truth were there, shown in many ways that were instructive to the visitor. The form of camp, the interior fittings, the meals served, the implements and tools of the logger, the sleds and railway-equipment are all to be found to-day in the bush, in every respect identical with those exhibited at the Fair. The load of logs there shown, containing over 36,000 feet (board measure), was hauled by one team almost a mile upon the regular ice-logging road of the Nestor estate, at Baraga, Michigan. It illustrated in a striking way the ease with which heavy loads may be hauled upon the ice.

The same general conditions obtain in the lumber industry in the states of Michigan, Wisconsin, and Minnesota, which constitute the great sources of white pine in the northwest. The importance to the whole country of this industry, by reason of its volume and of the number of allied interests, is so great as to prompt the writer to offer to the readers of the Magazine some details of logging-camp life gained by personal investigation.



In the purchase of pine-timber land, the first step is the employment of a "cruiser" or land-looker, who estimates the number and size of the trees and notes the character of the land, course of streams, etc. With his camp-outfit on his back and a sun-compass as a guide, he makes his way through the pathless woods as easily and with as much assurance of safety as one would walk the streets of his

native city. The land has already been subdivided by United States government surveyors into tracts one mile square, with posts marking the half-mile points. With this much to guide him the land-looker starts at the northeast corner of the tract to be estimated. [See *A* in the diagram.] Then, walking along the north boundary line toward the west for 125 paces, he counts the pine-trees, and estimates their contents in board measure: he then walks south 250 paces, estimating as before the pine-trees on each side of the course he is following; then west for the same distance: then north, to the north line of the land under examination: then west again for 125 paces. At the point now reached [*B* in the diagram] he will have completed the work deemed necessary to estimate the probable yield in feet (board measure) of a

LOGGING HORSES ON PARADE.

tract of land one-quarter of a mile square, containing forty acres. Each forty-acre tract is similarly estimated. When the trees are very numerous an acre is paced off, the trees counted, and their contents estimated; the whole area of closely-timbered land is then estimated, and in this manner a close approximation is obtained of the number and size of pine-logs the land will yield.

A log twenty-six inches in diameter and sixteen feet long will cut 500 feet (board measure), and such a one is considered of exceptional size. Michigan has patches of timber that will cut three logs to the thousand feet, but they are small and isolated. Twenty-five years ago, when the cut of timber was coming mainly from the lower peninsula, it was not unusual to get logs that would run one and one-and-a-half to the thousand feet. They were known as "cork pine," of which

GOING TO WORK IN A MICHIGAN LOGGING-CAMP.

there are now few to be found standing. Some tracts of pine lands have been cut over three times, each cutting proving a commercial success. In Minnesota the white pine is not of the same uniformly good grade as that from Michigan, being smaller and somewhat more knotty. Logs there run from five to eleven to the thousand feet, while instances have been known of a lot of logs running even twenty-two to the thousand feet being sent to mill—the latter material yielding of course very small and inferior lumber. Northern Wisconsin logs are of as high grade as those of Michigan, being grown in practically the same timber area.

NOT AN UNCOMMON LOAD.

Stumpage, or the price at which the owner of the land will sell the standing pine, varies, as it is dependent on the quality of pine; that is, its freedom from shakes or knots; the size of logs; whether the trees are well bunched or badly scattered (this point involving the cost of hauling); and, finally, their proximity either to a railroad or to a stream upon which they may be "driven" (floated) to a mill. It is a strange fact that, in spite of the constant cutting of pine and its probable total exhaustion (if the present rate of cutting be maintained), the price of lumber has, for the past twelve years, remained practically at the same figure, while the price of pine stumpage has doubled. Lumber has ranged from $10.50 to $14.50 per thousand feet (board measure); while stumpage, which formerly ranged from $2.50 to nearly $5 per thousand, is now quoted at from $3 to $7. This is due largely to the increased extent of logging operations and

LUMBERMEN AT DINNER IN THE PINE-WOODS.

"SNAKING OUT" LOGS TO THE SKIDWAY.

greater facilities obtained through mechanical appliances, which reduce cost and effect a saving of the material. The day of a chopper swinging his axe into the heart of a soft pine, filling the wintry air with the music of falling chips, has given way in the last ten years to the humdrum of the two-handled cross-cut saw. This prosaic change effects a marked saving of lumber when the butt-log is sawed in the mill.

The felling of trees begins usually in the early fall and continues until winter has well set in. After felling, the trees are trimmed of their branches, cut into advantageous lengths of 12, 14, 16, or 20 feet each, and "tonged-out" by horse and chain to a skidding-place near the main logging-road. Here they are piled, one on top of another, into a rough pyramid, about twenty feet in height and of such length as the logs cut in the vicinity will permit. A sort of rough cribbed foundation is laid on the ground for the logs to rest upon.

With the advent of snow and cold weather, the logging-roads are laid out, "grubbed," and cleared away for a width of twenty feet, usually in the low-lying ground. When practicable, they are run over swamp-lands. The grade must be kept in favor of the loaded sleighs as much as possible. There are few keener pleasures than is afforded by a ride behind the headquarters team, with the reins in the superintendent's hands, over miles of these boulevards of ice. The roads are kept up at great expense. During the day men are constantly at work, leveling irregularities, and at night, when the weather is cold enough to freeze, the roads are thoroughly "sprinkled," so that by morning the sleighs glide easily over them, with their loads of from four to seven tons drawn by a single team.

An exceptionally large load of railroad-ties was recently hauled over one of these ice-roads. A special rack forty feet long was constructed, which the foreman began to load with ties two-and-a-half miles from the banking-ground. When the load was completed the sled was still a mile from the bank. On that rack were piled 822 standard ties, in twenty-one tiers, and the weight was something less than forty short tons. A single team handled it, and delivered the load safely. The grade was down-hill somewhat, but of course very slightly so. These sleighs for hauling logs are massive, having a tread or track of five feet six inches, a width of ten feet, and a length of nine feet. At the outer ends of the cross-pieces iron teeth are inserted, which serve to keep the logs from rolling off until the binding-chains are in place and the load secured.

At times the roads leading from the skidding-places to the log-bank cannot avoid steep hills. With such loads as are usually drawn it would be dangerous to run them down-hill on the snow. The road is therefore made bare here and there, shovelfuls of snow being thrown where the runners will receive the benefit, and allow the load to partly slide and partly be drawn down-hill. When going up-hill, road-trimmers, jocularly called "snow-birds," throw on enough snow to permit the sleds to run freely. The sleds alone are a very heavy load for the team to draw up these hills. On the arrival of a load at the banking-ground, the logs are rolled off and piled in convenient places which have been prepared to receive them by laying logs at right angles to the

A SMALL BANK OF LOGS.

bank of the stream. When the logs are all delivered to the "bank," and the early spring thaws fill the streams, the driving begins, lasting usually through the four months succeeding April.

When the operations are extensive and the trees are closely grouped, sleds and ice-roads are replaced by regular logging locomotives and trains of flat-cars. The objection to them is that of initial outlay for plant, and the somewhat more expensive road that has to be built, as the road-bed is usually made upon solid ground, which costs for grading, ties, rails, etc., upon an average, $4000 per mile.

Steam-loggers have been tried, but without proving entirely satisfactory. They are in appearance not unlike some of the steam street-rollers, with large, wide-toothed wheels to obtain a grip upon the ice or snow; but, owing to their weight, they are not as successful as the steam road-locomotive. Their tractive power is dependent upon their weight, which makes them clumsy and difficult to handle.

The log-drive, beginning with the spring freshets, presents many points of interest, with the rush of waters, falling and boiling along in their rocky channels, carrying the logs sometimes quietly and easily where the grade of the stream is light, and again throwing them up on end, side-wise, tumbling over and around each other, plunging as they go through a dam and over the apron into the pool beneath, to be carried onward to the mill. Occasionally the logs are stranded: then the log, resting on the shore and reaching into the stream, with little difficulty persuades others to remain in its company, until very soon a jam is formed. With shoes provided with iron spikes, and with a long steel-pointed pole, the drivers walk on the round logs, as easily as on solid ground, to the jam. By lifting and prying with pevies,* they free the logs and allow the moving water to take up its burden and hurry it on to the loading-place or mill. When the jam cannot be thus readily broken, dynamite is often used with success; but it is not resorted to except in extreme cases. The dexterity and agility of drivers are astonishing. Upon logs of all sizes, bobbing, floating and rolling, they walk, stand, and ride. The bucking broncho is a rocking-horse compared to these saw-logs with their treacherous antics. Tests of skill are at times attempted between expert drivers, by two of them getting upon one log and turning it rapidly by running, as a squirrel turns the wheel in his cage, when one contestant will attempt to check it, and thus throw the other driver into the water. Chill and frequent are the baths these men daily receive, often spending the entire day in the water that is fresh from a snow-bank. Owing to the short period of high water, their hours are very long; indeed the hardest part of the

* A logger's implement for turning or rolling logs, consisting of an iron-pointed wooden lever and an iron hook hinged at the end. R. A. P.

SOME PRETTY GOOD-SIZED LOGS.

life in lumber-camps is that of driving, as the drivers are often at work by 4 o'clock in the morning and remain at it until they can see no longer at night.

The men in all the camps, cutting, hauling, and driving, are exceptionally well fed. The bill of fare is varied, and of excellent quality. Meats—fresh, salt, and smoked—are supplied in abundance; fish, vegetables, pickles, dried fruits, pie and cake of many kinds, with tea and coffee, are found upon every table. I lately chanced to see a bill of goods ordered which was intended to sustain a camp from the middle of February to the middle of April, and among the items were 2 tons of ham, 2 barrels of syrup, 10 barrels of corned beef, the same amount of pork,* 320 pounds of tea, 10 barrels of sugar, 1 ton of lard, 1 ton of butter, 100 pounds of coffee, 100 pounds of baking-powder, and 40 pounds of pepper. Such are the general store-items called for, for about 200 men. Prunes, raisins, currants, mince-meat, apples, etc., form the sweets that are part of the dinner and supper of each day, while such staples as potatoes, beans, and flour are distributed to the several camps in enormous quantities.

A COOK AND HELPER.

Having briefly followed the course of the log from the hillside to the mill or railroad, it may prove of interest to examine into the extent and value of the forest- and sawmill-products. In a United States census bulletin giving statistics of lumber-mills, sawmills, and timber-products of the white-pine states of Minnesota, Michigan, and Wisconsin for the last census year, the following extraordinary figures appear:

Value of forest produce not manufactured at mill	$ 30,426,194
Value of mill-products (lumber sawed)	115,699,004
Value of manufactures (staves, heading, lath, and shingles)	21,112,618
Total	$167,237,816

* Owing to the approach of soft or warm weather, this amount of salt meat is ordered, as fresh beef would not keep well enough, though quantities of the latter are sent in each week.

THE USE OF A LOCOMOTIVE IN A LOGGING-CAMP.

The production of this value required an investment of capital amounting to $270,152,012 : the employment in the forest of 95,367 persons and 32,491 animals ; the labor in the mills of 89,238 persons ; the removal of 1,262,151,180 cubic feet of merchantable timber of natural growth : the investment of $7,890,254 in vessels, railways, and waterways, specially used in this industry for the transportation of its material and product ; and, finally, the expenditure of $99,688,256 for wages, subsistence, supplies, and miscellaneous expenses. The ratio existing between the three white-pine states, involving the total value of mill-products and re-manufacture, is 7 for Michigan to 5 for Wisconsin and 2 for Minnesota, which figures closely approximate the relative importance of the industry in each of these states. In the census report the value of the pine stumpage consumed in the year 1890 is estimated at $13,100,043 for Michigan, $7,526,550 for Wisconsin, and $1,576,918 for Minnesota.

The production in 1890 of sawed lumber, not including shingles, staves, heading, and lathes, was :

For Michigan	4,311,240,000	feet	B. M.
For Wisconsin	2,861,517,000	"	"
For Minnesota	1,028,665,000	"	"
Total	8,201,422,000	"	"
[Total for Michigan for 1880	4,172,572,000	"	"]

If we assume a price of only $12.50 per thousand for the entire cut, its value in the census year 1890 was more than $100,000,000 in that one item, and, as there has been practically no difference in the amount cut in the state of Michigan between the two census years 1880 and 1890, it may be safely assumed that that state has produced annually for the past thirteen years over $50,000,000 worth of sawed lumber. The magnitude of these figures is startling to those who have not given the subject attention and are suddenly brought face to face with the importance and value of the industry.

The question naturally arises, how long can this enormous rate of cutting continue? The supply " which, a few years ago seemed so great that to attempt an accurate estimate was deemed too difficult an undertaking, has since then become reduced to such small proportions that the end of the whole supply in both Canada and the United States is now plainly in view."

In a recent report to the secretary of agriculture, the chief of the forestry division made the following statement : " The annual product of this pine from the sawmill has reached the enormous total of over 8,000,000,000 feet (board measure), which, if we assume a pine stumpage of 5000 feet to the acre—a high average—would require the cut-

SLEEPING BUNKS IN A LOGGING-CAMP.

ting of 1,600,000 acres annually of the white-pine supplies. Since the three white-pine states (Michigan, Wisconsin, and Minnesota) have a reported forest-area of altogether 60,000,000 acres, it is evident, that even if we allow-two-thirds of that area to be in the white-pine belt and consider this area fully stocked (which it is not), twenty-five years would suffice to practically exhaust the supplies. These figures, crude though they be, leave no doubt that the end of this staple is practically much nearer than we have supposed; all opinions to the contrary may be set down as ill-founded."

While it is true that we still have vast quantities of the red wood in the northwest states, its remoteness from market will always prevent its extended use in the middle and eastern states; the only solution to the problem of the future supplies of white pine lies in following the example of European nations which have made forest-growth a study for years, and now are reaping the benefit of their foresight. They control the cutting of the newer growths and reforest the cut areas. Owing to the fact that timber-lands are almost entirely owned by individuals in this country there can be no regulations as to the cutting; the scarcity of pine has not as yet driven any one into the business of forest-growth, though it can be demonstrated that it has the elements of success and, in certain localities where freedom from forest fires can be had, that it would pay if carried out upon a proper scale.

The three white-pine states have enormous areas of land from which the pine has been cut and which has been found to be of poor quality for farming. The hard-wood lands yield a soil that is available for potatoes and the cereals. This cut pine land should be restocked and sown to pine. The owners of such lands should be induced to do so, as every tree planted and grown adds to the wealth of the state and nation. The legislatures of these states should enact laws which will foster and encourage such work, and should exempt from taxation, for a period sufficiently long to yield a fair-sized tree, say fifty years, all lands so cultivated. Should the lands subsequently be found to be mineral-bearing and produce mineral, then it would be only fair to so adjust the tax-exemption as to permit tax-collection upon such mineral-bearing areas.

The United States government has fostered the European idea of forest rehabilitation and has established a division of forestry under the department of agriculture. But the attempts made at planting pine-trees under its direction are isolated, and the results have been meager. In New England old fields or farms which are growing up to pine by spontaneous seeding are usually not allowed to grow to timber, being cut for box-boards when thirty to thirty-five years old.

It is distressing to think that the future holds no promise of a continuance of this wealth-producing resource, and that in a few years many who read this will wonder where the forest is that it was once deemed "impossible to accurately estimate." To be sure, we are getting to be a nation of users of iron and steel, rather than of wood, as the consumption of iron per capita has increased from 117 pounds, in 1885, to rather more than 300 pounds in 1890, the whole of which we produced in our own country; while the cut of pine has increased at a very much lower rate. It is self-evident that, as the stores of the latter diminish, we must husband them by drawing more heavily upon our mineral reserves.

AN UNSETTLED QUESTION IN VENTILATION.

By Leicester Allen, A. B., M. E.

WHETHER, in ventilating a crowded assembly-room, the air should be made to move upward or downward is still a matter of debate. For the credit of that branch of engineering devoted to heating and ventilation it is time this question was definitely settled. Whether the nature of the requirements for good ventilation demands that the entrance of fresh air should be at the bottom and the exit of vitiated air should be at the top, whether this method should be reversed, or whether a compromise between these two methods is better or worse than either used singly, ought to be positively decided, unless the obtaining of necessary experimental data be from the nature of things so difficult as to baffle scientific investigation,—a view which I, for one, am unwilling to entertain.

About three years ago the writer was called into consultation within a short interval by two different building committees, to assist in their decision upon the relative merits of proposals for ventilating two church-buildings designed by different architects. The heating and ventilating plans for one of these buildings provided for expulsion of air through openings in the ceiling of the auditorium, while those of the other building contemplated the removal of air through registers opening at or near the bottom of the room, and connected with specified ventilating ducts and flues. I was told that in each of these sets of plans the direction in which the air was to be moved in the space to be ventilated was determined in advance for the engineers who designed the different plans, the architects of the two buildings having respectively made the direction of movement a limiting condition in their requests for plans, specifications, and estimates. Each of the architects *knew* that the direction of movement he had prescribed *was right*, as I was informed in subsequent separate conversations with them. Each had performed experiments in buildings, and one had found uniformly more carbonic acid in the lower part of the rooms experimented in, while the other had always found more near the ceiling. The former accounted for the accumulation of carbonic acid near the floor by the greater specific gravity of carbonic acid as compared with air. The other was positive that the carbonic-acid gas, when issuing from the lungs in a crowded hall (being heated to the temperature of the blood), must be very nearly of

the same specific gravity as that of the air into which it was expelled, and that, being mingled also with nitrogen at blood heat, the specific gravity of the mixture would be such as to cause it to be carried up to the ceiling by ascending currents of warm air; and, hence, that the results of his experiments were thus sufficiently accounted for. I asked him if he could point to an authority for the specific gravity of the mixed gases of exhalation at the temperature of expulsion, but he could not name any. As for the skin being an excretory organ which eliminates carbonic acid unmixed with free nitrogen and at a somewhat lower temperature than that of the breath, he seemed never to have heard of such a thing. Neither did he appear to have considered the possibilities of other emanations from the human body in health or disease. The contamination of the air by breathing appeared to be the only aspect of the subject he had considered. However, he rested with entire confidence on the soundness of his opinion.

The other architect was equally ready to maintain that his theory was correct, and that it adequately explained the alleged tendency of carbonic acid to collect in the lower part of a room containing an assembly. Among the arguments this gentleman used in support of his view, I remember that much was said about the accumulation of carbonic acid in wells, etc., the gas running into the wells and displacing the lighter air.

These samples of divergence in opinion are, I think, fair specimens of what may be met with, not only among architects but among others who have more or less studied ventilation. The object of this paper will be to point out what is lacking to a final settlement of this question, and to suggest experiments which must be performed in order to obtain the yet missing data. When these are supplied and the question is reconsidered in the light of additional knowledge, it may turn out that local conditions will determine which direction is best for any special case, and that these conditions may vary from time to time in the same building—and even in the same room—so as to render any absolute and invariable rule impracticable in its application.

Perhaps I ought to have said earlier that this question is principally important as it concerns ventilation through shafts by currents generated directly through the action of heat. When mechanical means are employed to force and control ventilation it may be made so positive and copious as to give good results under almost any set of conditions. Probably those who entertain positive opinions relative to upward or downward movement of air in rooms to be ventilated by heated currents in shafts base their views chiefly upon the assumptions that the removal of carbonic acid to an extent that maintains its percentage at a given low point is, in itself, all that is required for good ventilation,

and that the removal of carbonic acid must be accompanied by that of all other noxious exhalations of whose presence carbonic acid is thought by many to be the sure and inseparable sign. I do not think that the act of removing the sign of the offending matters logically implies the removal of the offending matters also. However, the correctness of the assumptions in most cases will be generally admitted, but they cannot be correct for all cases and every set of conditions.

In the first place, noxious gases may be present that are not indicated by the simultaneous presence of an undue amount of carbonic acid, and are not introduced with the latter from the same source,—the lungs. Such was the case with the air in a school in Alpena, Michigan, recently described by Professor S. Dewey;* also in a case of a school, cited by Fred P. Smith,† where multitudes of flies, as well as quantities of fetid gases from closets, entered through ventilating-flues. Carbonic oxid may be escaping into the apartment from a leaky furnace or smoke-flue. Compounds of hydrogen or ammonia with sulphur may be present, together with other fetid vapors introduced from water-closets or defective soil-pipes. More or less contamination of the inclosed air may occur from the leaks in gas-pipes and gas-fixtures that permit unconsumed illuminating gas to enter apartments.

These gases are not all of the same specific gravity. Sulphuretted hydrogen, like carbonic acid, is heavier than air; while carbonic oxid, one of the deadliest of gases, and illuminating gas are much lighter than air. Here, then, we have two gases, both liable to be present in apartments, and both of a noxious character, whose tendency would be, under the action of gravity alone, to seek the ceiling instead of the floor. Unpleasant symptoms would be produced by a far less quantity of these gases than would be needed to make the presence of carbonic acid objectionable or even sensible through its effects upon the human system.

If gravity plays any important part in separating light gases from heavy ones the indication would be, from these facts, that the contaminated air should be taken partly from the top and partly from the bottom; because, if these gases remain unmingled with the inclosed air and find no exit at the top, some of the most noxious may rise and gradually accumulate at the top, filling the room in a downward direction till they reach a level where they are liable to be inhaled. On the other hand, carbonic acid, sulphuretted hydrogen, and phosphuretted hydrogen would seek the floor, and the region of purest air would lie between the floor and ceiling at some intermediate but indeterminate height. Unfortunately for the tenability of the theory that the heavy

* In the *Pacific Builder*.

† In *Heating and Ventilation*.

gases fall out of the lighter ones, it is a fact that all gases tend to mingle with each other in uniform mixtures; and this tendency is such that, if time be allowed for its action, not only will it overcome the resistance due to the difference of specific gravity, but it is also competent to overcome very much greater resistance.

If a jar containing hydrogen gas be inverted so that its mouth covers exactly the mouth of a similar-sized jar containing carbonic-acid gas, although hydrogen is twenty-two times lighter, bulk for bulk, the former will go down against the action of gravity, and the carbonic acid will go up into the upper jar, so that in a few moments the jars will be found to contain equal weights and equal volumes of hydrogen and carbonic acid. The experiment affords a striking illustration of the law of the diffusion of gases, because the extreme difference in the specific gravities tends strongly to keep the gases separate. Although there is far less difference between the specific gravity of air and carbonic acid, the same tendency to diffusion exists in a much greater degree when these gases are put into the same inclosure. If a jar be filled with carbonic acid, and a piece of pure elastic sheet-rubber be tied over the mouth of the jar, the lighter air will find its way into the inclosed gas, forcing its way through the very texture of the rubber diaphragm, and as the mixed air and carbonic acid cannot again pass through the membrane, the latter, if firmly and tightly fastened, will stretch and swell out as the air passes in, assuming a balloon-like form, or it may ultimately burst under the accumulating internal pressure.

We may reverse the experiment by tying the diaphragm over a jar filled with ordinary atmospheric air and placing the jar mouth downward, under a bell-glass inverted in mercury and filled with carbonic acid. When this is done the rubber membrane will be gradually pressèd into the jar as the air passes out, and, unless torn under the rapidly accumulating pressure, it will be forced into the jar till it reaches the bottom. While there are no exceptions to this law of diffusion of gases, the rates at which the different gases diffuse into each other have not been determined. Until careful experiments have determined the time required for different gases to permeate definite volumes of other gases some of the questions relating to the art of ventilation cannot be authoritatively answered.

Some who have endeavored to study the question whether upward or downward movement is the better for ventilation have adopted a method of experiment which seems to me incapable of determining anything of value as regards a real solution of the problem. The method referred to is the generation of smoke in a closed room to ascertain whether it will rise or fall. One experimenter, of high reputatation as an expert in ventilation, smoked a pipe in a room containing

still air and assumed that the movement of the smoke, which was upward, was an indication of the direction and the rate of the motion of other constituents of the breath diffused into the contained air. That conclusions derived from such experiments are likely to be utterly misleading will appear when the above experiments in diffusion are considered in connection with the fact that there is not the slightest resemblance or analogy between visible smoke of any kind and a gas, properly so called. Anything that renders the air in the least opaque is not a gas. Visible smoke consists of minute solid particles diffused in the air, the action of which differs entirely from that of a gas flowing into any other gaseous body. Every gas possesses expansive force which tends to separate its particles as widely as possible, and if there be no restraining force, such as the walls of an inclosure through which they cannot pass, there is no limit to this expansion. In thus separating, the molecules of the gas move freely through bodies of other gases into which it may be injected ; but, as this motion of expansion sets up in every possible direction, it can cause no current in one direction more than in another. The gas while diffusing may, however, be carried along by previously existing currents or restrained from moving in any direction by an obstruction.

There can be no doubt that the temperature of any gas issuing into an apartment, as well as its specific gravity, has a temporary effect upon its tendency to rise or fall. If the gas be warmer than the air into which it issues, and if its specific gravity be less than air, these conditions will co-act to make it rise. If its temperature be less and its specific gravity be also less, these two conditions oppose each other in their effects upon the direction the entering gas will take, and it will not rise at all, or will rise more slowly than in the first instance. If its temperature be colder than the air and its specific gravity greater the conditions will co-act to make it fall toward the floor. Finally, if the specific gravity be greater than air, and its temperature be warmer, we have again opposed conditions ; the gas may remain temporarily near the point of ingress, it may rise or fall according as one or the other condition preponderates, or it may be borne along by currents, its natural tendency to move in either direction being thus overcome. But its tendency to expand in all directions will be influenced neither by its specific gravity, nor by its temperature, nor by preëxisting currents, with the single exception that the higher its temperature is the more rapidly will it expand and diffuse. It seems plain that, if the rate of expansion of one gas into another be greater than the rate of flow of any existing current, the entering gas will move in an opposite direction to that of the current, and in such a case the current will not be competent to wholly expel it from any

part of the inclosed space. And if it be specifically lighter or heavier than air its mixture with air will be correspondingly lighter or heavier than air, and it will accumulate accordingly at either the top or the bottom of any space into which it enters. But if the rate of diffusion be less than the rate of flow in the purging current the gas must be carried along, notwithstanding its tendency to diffuse in an opposite direction, and in such a case there could be no accumulation.

To secure perfect ventilation the rate of diffusion of the noxious gases must be somewhat less than the rate of flow of air through the inclosure. In many buildings manufacturing operations are carried on that give rise to deleterious gases and effluvia, and this question becomes of great importance in considering the best means of ventilating factories and shops in which large numbers of operatives are employed. It is admitted by eminent investigators and authorities that in assembly-rooms, hospitals, factories, etc., it is not the carbonic acid generated by breathing that is to be dreaded so much as the other noxious gases and effluvia which the presence of carbonic acid in excess indicates and measures. But in a room lighted or heated by gas there may often be an excess of carbonic acid without excess of other gases. Only under certain conditions, wherein the presence of carbonic acid in excess is known to be caused by exhalation, can it be a true measure of the presence of objectionable substances. How could this standard be employed to determine the presence of carbonic oxid issuing from defective heating apparatus, which gas has no smell and which is not a product of respiration? How could it determine qualitatively or quantitatively the presence of sulphuretted hydrogen, phosphuretted hydrogen, or illuminating gas? Yet all these may be present, sometimes in so small quantity as not to be separately distinguishable by smell, although other effects might be very perceptible. And unless their presence be determined by other tests than the presence of carbonic acid the sanitary engineer has no guide to the true source of contamination.

There is yet something to be learned in the art of ventilation through the experimental acquisition of new facts. If, in some of the laboratories of technical and scientific institutions, experiments directed to determine rates of diffusion of different gases that may be present in occupied rooms could be carried out, and if data could be supplied as satisfactory as have been furnished upon many other important points relating to heating, ventilation, and refrigeration by such institutions as Cornell University and the Stevens Institute of Technology, all unsettled questions in ventilation might soon be answered definitely and authoritatively.

THE KITE AS A LIFE-SAVER AT SEA.

By J. Woodbridge Davis.

THE life-saving kite, as some witnesses of its performances have called it, was designed originally as a huge plaything. It had an extensive surface to gather a great power from the wind; it was strong and durable so that it might be used many times; it was necessarily foldable for transportation and carriage through hatchways; and it was rigged in such manner that its motions in mid-air might be compelled and guided from the ground. The problem of designing it proved to be interesting. It was found that, corresponding to a package of given length representing the folded kite, the maximum spread of surface could be obtained by making the three ribs equal, pivoting them together through the middle of each, and spreading them so that the six angles formed should all be equal. Hence would follow a hexagonal kite; but as a plane with sharp, salient angles flies steadier and the covering material stretches tighter, so the binding-cord is drawn in between the sticks and the kite becomes a regular six-pointed star.

The most difficult problem was the designing of the sticks for maximum lightness and strength. The distribution of wind-pressure upon each stick, as received directly along its length from the covering, and indirectly to the stick's ends through the intermediation of the perimetral binding-cord, being determined, and the opposing strains in the six bridle-strings, known to be the total wind-pressure equally divided, being considered, the bending and shearing forces at every tenth of a semistick were ascertained, with the wind-velocity, size of kite, and position of bridle-strings represented in the formulæ by symbols but left undetermined in value. As the strength of the framework depended much upon the position of the bridles, the position was treated as variable, and the best value deduced, which thus became a numerical constant.

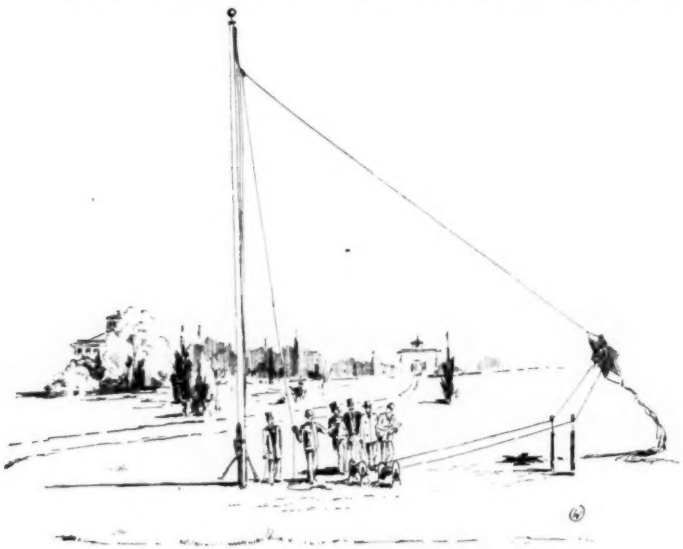
A feature of the discussion was the introduction of a variable safety factor. In a light breeze we can add little to the strength at the expense of buoyancy, but, so rapidly does the supporting power increase with the wind's velocity and so necessary does a greater safety margin then become, we both can and should, in the new condition, give a superabundant strength to the framework. An economical safety factor was found by experiment for a forty-mile wind, and made to vary from this value as the cube-root of the wind's velocity varies, and this was incorporated in a formula suitable for de-

signing a kite of any size for any wind. According to this formula, a seven-foot kite, weighing six pounds, will safely bear a strain of 250 pounds; then, if the dictum of authorities be true that the tension between a team of horses and a ton of hay on the level part of an ordinary country road is 100 pounds, this kite will drag a train of tons along a level boulevard, or cause a canal-boat to glide through its narrow water-way with all the mules aboard.

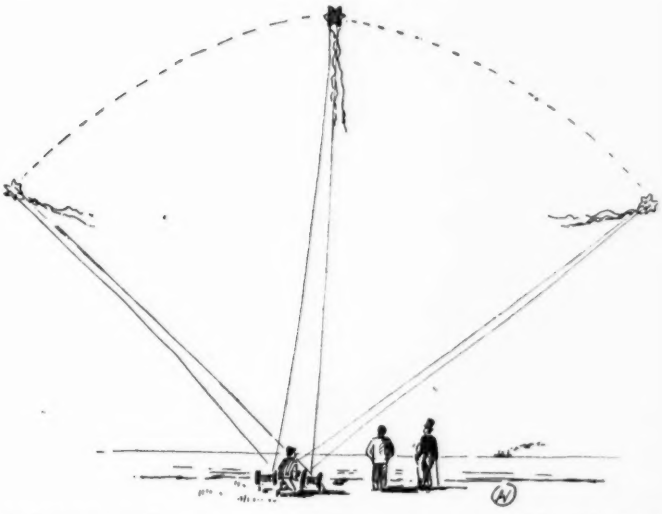
A problem not to be solved by calculation was to find the fittest material for the wind-surface. Many stuffs in the market were tried, unoiled and oiled. The former allowed more or less air to blow through, and the latter were either too fragile or too heavy and stiff. Alpacas and other materials never before oiled were put through the process until a fabric was found, light, strong, and pliable under the oiling, so that now the kite can be folded as neatly as a silk umbrella. It requires three weeks to make the cover—as long as to make a fisherman's sou'wester—both being made by the same process and in the same factory.

The kite's tail is made of clothes-line, hung on in four or five 100-feet lengths. When the kite whisks its tail in a high wind, the way it whistles and shrieks and snaps is terrible to hear.

The kite is managed with two lines which are used like reins in



RAISING THE KITE WITH A TOP-LINE.

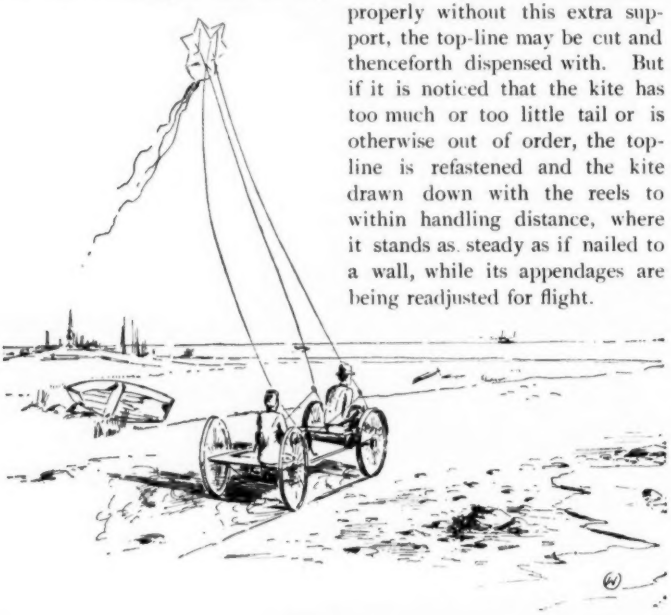


LATERAL DEFLECTION.

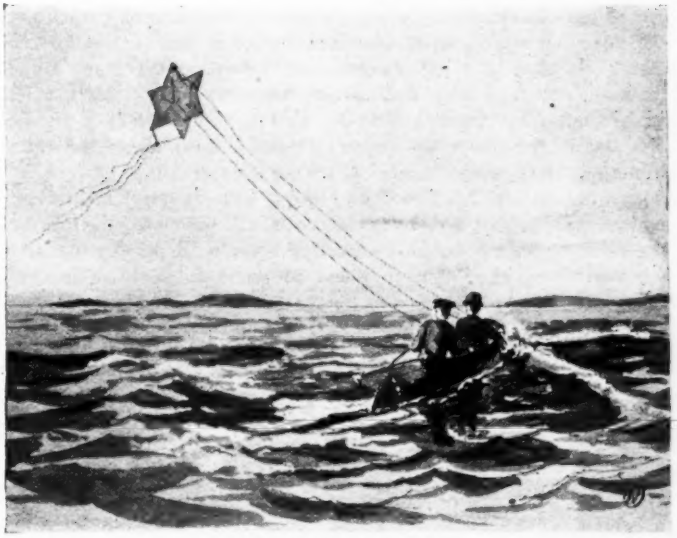
driving, and with the same effect. On the right side of kite three strings are fastened to the three sticks in a vertical row, and brought together to a grommet to which the right-hand fly-ing-line is attached. The same arrangement exists independently on the left. A top-line is also used as an auxiliary in raising the kite. It is a light, strong line, such as is employed by masons in lining up walls, and is attached to a band connecting the two top points of the kite.

The outfit is put in service thus: If on a lawn, two stakes four feet high with pulleys lashed to their tops are driven eight or ten feet apart in a line perpendicular to the wind. A few yards to windward two reels, containing the two flying-lines and provided with ratchets and band-brakes, are pegged down close enough together to be worked by one man, each facing one of the stakes. The kite is carried to leeward and spread, which involves simply the labor of tying four points of the cover to the ends of two ribs, the third rib being already attached when folded. The flying-lines are carried from the reels through the pulleys on the stakes, which act as fair leaders to, and attached to, the bridles on the right and left sides of the kite; the tail is hung on and the kite let go.

But a more interesting and efficient way of raising the kite is by means of a top-line and flag-staff, the latter standing close beside the reels. A pulley is lashed to the halyards; through this is run the top-line, from a ball wound on a stick and played out from the hands, to the top-band of the kite. Then the pulley is hauled aloft and all is ready. The kite now can be put in flight from immediately in front of the stakes, and by one person. While the kite lies on its face a few feet to leeward of the stakes, the operator winds in the slack of the flying-lines and clamps the reels. Then he lays hold of the top-line and hauls in enough to lift the kite six or eight feet from the ground, and fastens the top line so to a cleat. The kite is held as in a vise by the two flying-lines and the top-line acting like guy-lines against the wind's pressure. The operator returns to the reels and lets out the lines by using either the cranks or band-brakes. The kite rises in the arc of a circle whose center is the pulley at top of staff and whose radius is the length of top-line. So easily and safely can this be done that it is a pleasure to haul in and let out the kite with the top-line fixed. Next the reels are clamped and the top line slacked; if the kite behaves properly without this extra support, the top-line may be cut and thenceforth dispensed with. But if it is noticed that the kite has too much or too little tail or is otherwise out of order, the top-line is refastened and the kite drawn down with the reels to within handling distance, where it stands as steady as if nailed to a wall, while its appendages are being readjusted for flight.



A KITE MOTOR.



AN UNCAPSIZABLE SAILBOAT.

To fly the kite and feel it tug like a wild horse, yet see it gracefully sweep and sway in obedience to the impulses sent aloft from the reels, and to hear the occasional swish of its tail, is exhilarating sport. Wheel in the right-hand line and the kite moves steadily yet swiftly to the right far off the wind; cease winding, and the kite stands still; persevere and it progresses until it has described three-fourths of a right angle from the leeward point. As it moves, it gradually descends and as gradually inclines its head to windward, the tail streaming out behind. At the extreme deflection the axial line of kite and tail seem nearly parallel to the horizon. Release the right-hand line, and back the kite rises to its summit, and on it sweeps to the leftward quarter, until its axial line is parallel to another horizon, having turned its head through many degrees so as always to point windward, while its path has been a rainbow whose span is three-fourths of the leeward half of the heavens.

To compel the kite to trace any curve in the air, the top-line must be used, and the bridles must be arranged so that the top and bottom strings are equal in length; in other words, so that the kite may have no slant, but be at right angles to the flying-lines. Without the top-line the kite cannot now be raised; with the top-line it can be raised, with or without the staff. When in flight, the top-line should be re-

moved from the pulley by hauling the latter down the staff, cutting out the line, and retying it. Clamp the flying-reels and use the top-line alone. Haul in, and the kite rises almost overhead, gradually losing its power of pulling; pay out, and the kite sinks until its tail touches the ground, describing a vertical arc at any point of which it may be held stationary. Its pulling power increases as it descends; the strain in the top-line is always small. Leave the left reel clamped; work the other with the right hand and the top-line with the left; the kite can now be made to dart hither and thither in all directions, tracing the letters of the alphabet or any prescribed figure. In one experiment a row-boat was sent out from an island and stationed forty or fifty degrees away from the direction of the leeward point; the kite was then directed over the boat and lowered; a message was pinned to the tail,

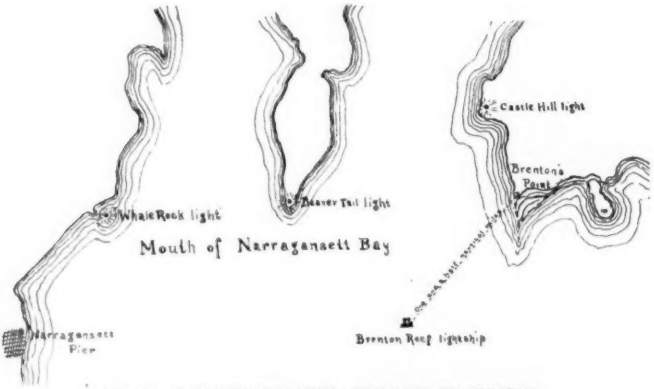
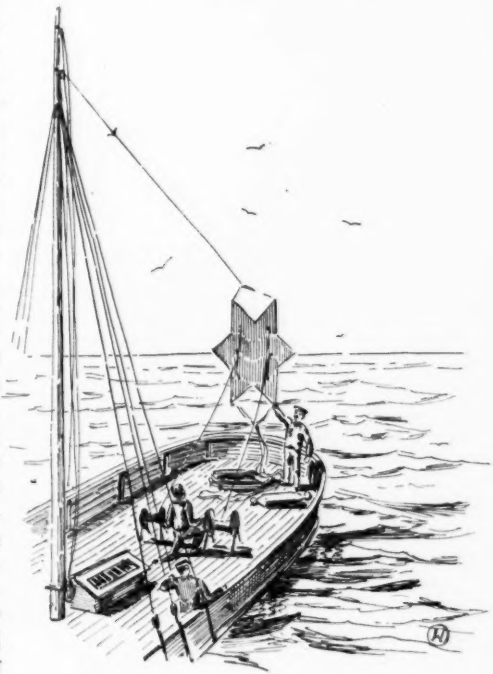


CHART OF THE BRENTON REEF LIFE-LINE EXPERIMENT.

which the kite whisked instantly to another place. This maneuver was rapidly executed.

The propelling power of the kite was exhibited at Arverne, Long Island, in the summer of 1892, where two young gentlemen from New York applied it to a wagon constructed for the purpose from special designs. Its platform is low and wide; all the wheels are of the same size—3′ 4″ in diameter—and strongly made; the track it leaves in the mud gages 4′ 8″. One passenger sits in the rear on a long low, seat so that he can slide his weight to windward when the kite is pulling abeam. His feet are deposited in a long well and thus keep the center of gravity near the ground. At his right and left are the two flying-reels in easy reach. Since one may be kept clamped, he can easily direct the kite with one hand. To his position comes also the top-

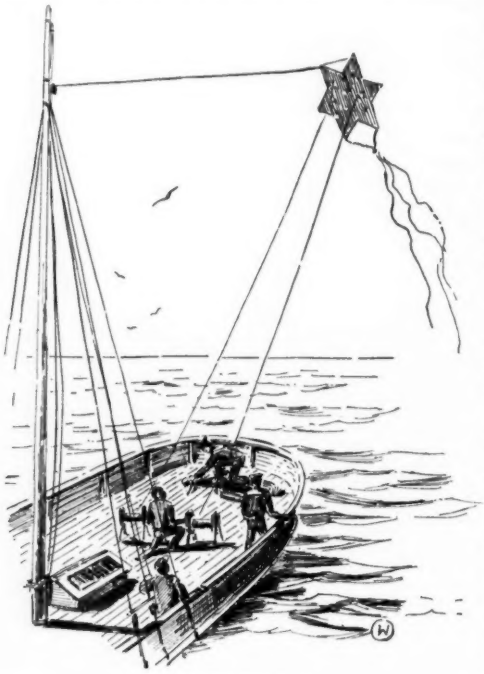
line, which he can fasten to a cleat or manipulate as he will. The passenger in front acts as the pilot. His seat is a little more elevated, and he can shift to windward also. His business is to work the horizontal pilot-wheel connected by vertical shaft with the front axle, and to apply the brakes to the rear wheels. The flying-lines from the reels come forward, each on its own side of wagon, and leave the vehicle through pulleys lashed to the side-rails near the front wheels, over which are guards to prevent abrasion of the lines. The wagon has also adjustable shafts to be applied for horse traction. These young men had no trouble in propelling themselves, even with summer winds, with a seven-foot kite along the sandy beach. The kite can be directed 45 degrees off the wind and the wagon steered 45 degrees further to windward, so that, with a breeze blowing directly in shore or off shore, the wagon can be made to travel up and down the beach. The top-line is never cut loose, as it is very serviceable. It prevents the kite from falling in a sudden drop of wind; it enables the operator to lower the kite to obtain the full force of the breeze, or to raise the kite almost overhead when it is desirable to slack the speed or stop the wagon. Afterward a ten-foot kite was constructed for this wagon, but it has not yet been used. It is planned to employ the kite in the near future upon a large deep-keeled canoe, with a similar disposition of apparatus.



RAISING FROM SHIPBOARD.

The remarkable tractional and steering powers of the kite led to its

trial in carrying out life-lines. A mile of rope was wound on a reel and carried to South Brother island. A loop was made in the forward end, and twenty feet back of this was attached a 32-pound wooden buoy. A seven-foot kite was raised. When about 400 feet had run out, the flying-lines were cut. One was immediately fastened to the loop at the end of the mile rope; the other was also fastened there after being drawn in so as to direct the kite to a pier on Riker's island, five-eighths of a mile distant and not directly to leeward. Then the kite was let go, and the buoy was dragged down the beach and went scudding through the water at a rapid pace, dashing the foam about it. At times it jumped like a porpoise eight feet out of water, and took forward leaps of fifteen feet. It was dragged over a reef near Riker's, and finally to the shore of that island.



TESTING THE TAIL.

The function of the buoy is apparent in this experiment. While the kite was at full speed, its lifting power diminished and it simply towed the buoy and line; when the speed was checked by the meeting of obstructions, and finally by the friction on the long line, the buoyant power increased, and the buoy was lifted over the obstructions, and, toward the end of the course, kept constantly suspended a short distance above the water. But, had there been no buoy, the kite would have carried up into the sky, out of reach and use,—a quarter-mile of line all wasted. A strong tide was sweeping through the

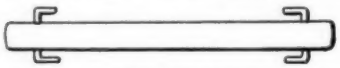
channel at right angles to the life-line, bearing it down-stream in a great curve; yet it seemed to have no effect upon the direct course taken by the kite and buoy.

The next endeavor was to try the kite on shipboard. But to charter a vessel and engage a crew expressly for the purpose of putting them within a mile of a lee-shore in a storm was out of the question. Therefore permission was sought to install the apparatus upon a light-ship, that at Brenton Reef being selected as being the closest in shore. Nevertheless it is 1½ nautical miles from the nearest land, the tip of Brenton's Point, and slightly farther from Beaver Tail, and several miles from any other shore. The task here set for the kite to perform was rather more difficult than is likely to occur in any case of shipwreck. The kite was required, in spite of the strong tides that sweep in and out of Narragansett bay, to carry a serviceable line 1½ miles to either of two points thrust out like fingers—to miss which would mean failure—with the wind perhaps not blowing directly toward either. Permission was heartily granted by the lighthouse board, although one of the members good-naturedly remarked that it would look like a long way from Brenton's light-ship to the shore.

After a three-days' wait for wind aboard a fresh breeze sprang up on the forenoon of the fourth from N.N.E., blowing off shore. The tide was about slack low. The stern of the ship was to leeward. The kite could not be sent toward land, but it was well enough in a first experiment to send it to sea. The trial was deferred until the crew had filled and trimmed the lamps and put the ship in order for the day. Then all hands from captain to cook collected to take part in the experiment. The life-line reel, which in this case carries two miles of manila rope, ¼ inch diameter, tested to bear 750 pounds strain, was faced to leeward, nailed down, and a buoy slung to the life-

AIMING THE KITE.

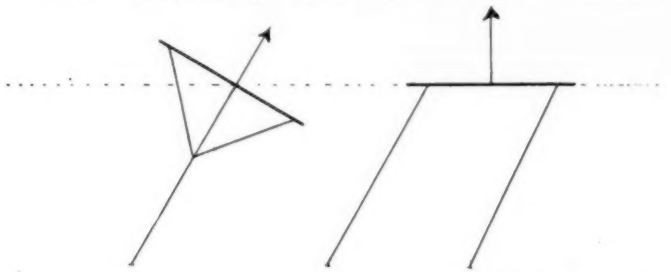
line. The flying-reels were nailed down side by side near the stern, the fair leading pulleys attached to the reels themselves. A seven-foot kite was brought on deck and spread, and the flying-lines separately tied to the two bridles on the right and left of the kite. Three sections of tail-rope were fastened to the tail-band. The top-line was rove through a small pulley and then tied to the top-band. The pulley was hauled up on the flag-halyards and the halyards wrapped around the mast cleat. A man held the kite at the rail, the pressure being taken up by the taut flying-lines. At the word the top-line was hauled in about five feet, hoisting the kite, and the flying-lines were paid out. Instantly the kite was sailing above the level of the masthead. The top-line was slacked, and it was noticed that the tail was too heavy. The kite was drawn in, supported by the top-line, and a portion of the tail cut off. It was launched again as before and found to be self-supporting when the top-line was slackened.



A STEERING IMPLEMENT.

The experiment of taking in and letting out the kite was tried repeatedly. It was surprising how easily this could be done. The top-line steadied the kite on the same principle as the tail, besides supporting it until it could be made self-supporting. The flying-lines steadied the kite laterally like guy-lines, besides steering it so that it could be accurately and steadily drawn in or let out through a space in the rigging scarcely wider than itself.

The accompanying diagram shows why a two-line kite is steadier,



even when flown straight to leeward, than a single-line kite. The pressure of the wind is always normal to the surface. When the single-line kite is deflected from the wind this pressure does not tend to bring it back; it is feebly urged backward by the wind-pressure on the mere edge; hence it wobbles. When the two-line kite is deflected it is forcibly pushed back and held firmly in position with the full vigor of the wind. It seems as easy to project the kite by means of

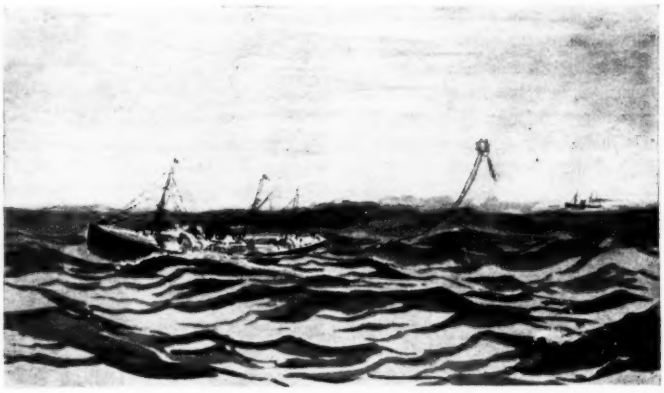
the pair of reins through a narrow gap in the rigging as it is for a man to walk through an open doorway.

The life line was sent out as follows: The kite was launched by means of the top-line, this was cut and allowed to slip free, and the flying-lines to play out about four hundred feet. Then these were cut and fastened to the loop in the end of the life-line. The kite was deflected 40 degrees off the wind by shortening one line. This was effected by winding the line about the instrument shown in the sketch, consisting of a stick with a double hook at each end. The aim could be taken with the greatest nicety by means of this device. The buoy was passed overboard, and the line ran out about a quarter of a mile,

SENDING A LIFE-LINE ASHORE

persevering in the course laid out for it. There it was checked while under rapid headway, the line drawn in, and the keeper placed in command.

He directed the kite straight to leeward and sent the line out a mile to sea in eighteen minutes, the line being marked with a leather tag at each quarter-mile. The first quarter ran out in two minutes, although two men were braking the reel with staves. The second quarter was not timed, as we stopped the line to try its pull, which was more than one man could hold. The third quarter ran out in 4½ minutes, and the fourth in eight minutes. Whenever the line was



PASSING A HAWSER FROM SHIP TO SHIP.

checked the kite immediately lifted the buoy fifty or sixty feet out of water, and dropped it again as soon as it resumed its headway. The same effect would be produced by obstructions, such as floating spars, reefs, and bars.

The sailors were delighted with the working of the kite, and their respect for it rose as they realized its power. The art of managing it they had instinctively learned the moment they had seen it harnessed on the deck. There, a mile away—a speck on the horizon, with the buoy a black dot bobbing in the air beneath—it was pulling like a horse, keeping the line exactly on the surface of the water as far as the glass could follow. As a barkentine came heading in from the south'ard, the sailors hauled away to save the line; but, seeing she would miss it, let the kite run out again to puzzle the stranger. The crew was gratified to learn that the apparatus belonged to the light-house department, and expressed the wish that it might not be taken from their ship.

When the kite had been hauled in flying to the deck, it was next seized and thrown over the ship's side into the water. By hauling on the lines it was raised and put in flight. It was found that this could be done with the flying-lines alone without the top-line by hauling on one only, which raised the kite partly and allowed the wind to sweep under it and lift it out of the water and put it in flight. The operation of the apparatus seemed so simple and certain that the keeper said he had no doubt he could land the line on Brenton's Point or Beaver Tail with a southerly wind, an auxiliary kite being fastened to the life-line a half-mile behind the first.

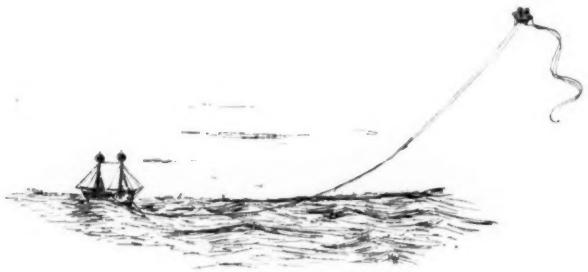
It is useless to make an appointment with the wind. An appointment was made for the wind to blow from the southwest on April 22, 1893, and a number of persons were invited to see the life-line come ashore. Sure enough the southwest storm-signal was flying over the custom house at Newport, and there was apprehension that the light-ship could not be reached. Several newspaper-men and other people drove down to Brenton's Point, and the neighboring life-saving crew turned out to watch for the incoming kite and line. But the wind was faint and the kite could not be cut from its top-line. So the kite-flier was reluctantly obliged to give over the trial, and bid adieu to the stationary mariners who trim lamps instead of sails and hang forever in the doldrums whether it blows or not.

The next day the wind did blow, and the crew hitched a kite to the end of the life-line, steered it carefully for a house on the tip of Brenton's Point, and let it go. To insure success they hooked on another kite half a mile behind the first, and had the satisfaction of seeing the forward kite go straight to its mark through the strong cross current of an ebbing tide. But not a soul was there ashore to note its coming or to detach the kite and buoy. So a boat was manned and sent after it, and the buoy was found beached some twenty yards to eastward of its aim.

In the bows of the ship lay a great pile of five-inch hawser, 200 fathoms long. As this was measured, marks were left at every fifty fathoms. The hawser weighed a ton. When it was suggested to fly the kite with this hawser, the captain was not amazed. The object of such an experiment was to determine the possibility of sending a towing line from a rescuing vessel to a disabled ship at sea, which in heavy weather is now an exceedingly difficult and dangerous proceeding.

On June 23, reports the captain, at 9 A. M., with a twenty-five mile breeze from the north, and a strong flood-tide from the south, a kite was sent out attached to the end of the hawser, without a buoy. The kite took the hawser off the deck itself, and towed out in 12½ minutes against the tide the entire 200 fathoms. The first mark went over the rail in 2½ minutes, the second in 3, the third in 3, and the fourth in 4 minutes. When the line stopped paying out it seemed for a moment to leap clear of the water. The pull of the kite was so great that six men were required to do some hard tugging to haul it back to the ship. The captain expressed the opinion that in a forty-mile breeze there were not men enough on board to haul in the kite and cable. Thus it was shown that a hawser can be quickly passed from ship to ship without hazard to either crew. In such real service, the labor of hauling back the kite in flight would not occur.

That a seven-foot kite could make such a strong pull against six men, the men pulling with the tide and the kite against it, seemed at first as unexplainable as it was unexpected. But the men hauled in by hand: it was heave, and then stop to get a new hold; the kite never stopped and never relinquished its hold. If the men spent two seconds to heave and six to get the next hold, during the latter interval the kite was unopposed in its work of overcoming the shipward momentum of the cable and impressing upon it a seaward momentum, and in the next two seconds the men encountered not only the present pulling of the kite but the adverse momentum of a ton of rope. At each new grasping the men found the cable running from them, not to a degree perceivable in motion, but noticeable in antagonistic power; if there had been no kite attached they would have found the line not obstinate but consenting. However, the animate prevailed over the inanimate; the kite was drawn to deck and laid away pinioned in its chest, thus ending what was to these sailors a memorable tug of war.



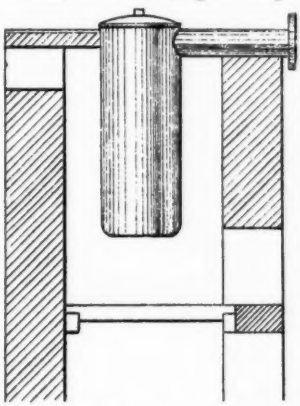
A TUG OF WAR.

COAL-GAS AND WATER-GAS COMPARED.

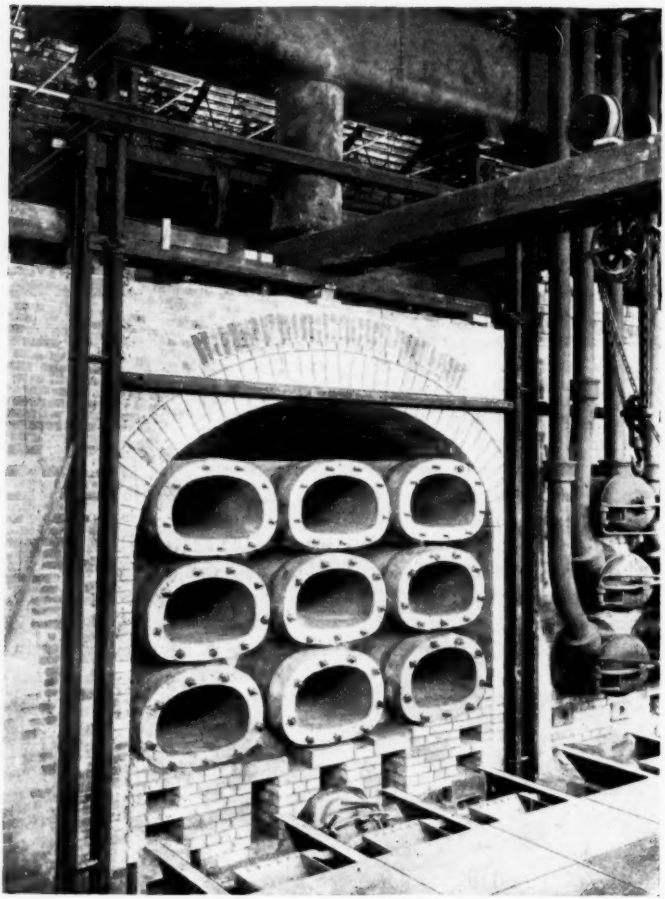
By C. J. R. Humphreys.

IN treating of the two general plans of gas-manufacture covered by the title of this paper, it is proper that we should first consider the coal-gas process, because it is the older; it is in fact the pioneer scheme of gas-making and is to-day the process most generally used. The science of gas-lighting grew out of the discovery made by Van Helmont, in the sixteenth century, that the dreaded "will o' the wisp" was merely an air or gas given off by decomposing vegetable matter. But the world profited nothing by this discovery until Clayton, investigating like phenomena some two centuries later, arrived at the same conclusion, and found, further, that a similar gas was given off by coal buried in the ground. Completing the chain by finding he could distill coal in a retort and produce gas, or inflammable air, as he termed it, the way was open for the discovery of gas-lighting. These facts coming to the attention of William Murdoch, of Cornwall, England, he was led to investigate the subject.

In 1792 he erected a small plant by which he lighted his house with this then strange air (or gas as we now call it), and this was at once the beginning of gas-lighting and the commencement of the coal-gas industry. In 1812 we find one Winsor, a German by birth but at that time residing in England, trying to start a gas company in London,—the nucleus of the present Gas Light and Coke Company, the first and largest gas company of the world,—and a year later we find Winsor lighting from his laboratory a portion of Pall Mall, this being the commencement of street-lighting by gas. The process used was the coal-gas plan, which has come down to the present day unchanged in principle, but greatly altered to meet the varied conditions of the business and the vastly greater demands made upon the sellers of gas, to produce the article in large quantities and at comparatively low costs. It would hardly be profitable to enter into a comprehensive description of



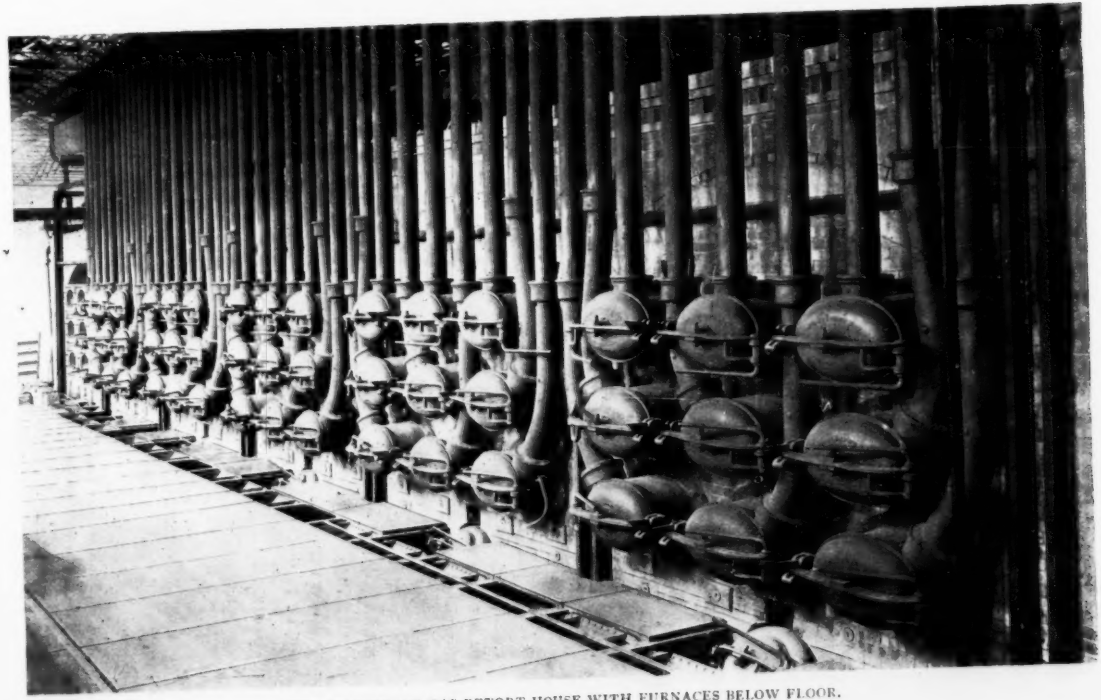
STYLE OF RETORT USED BY MURDOCH IN 1792.



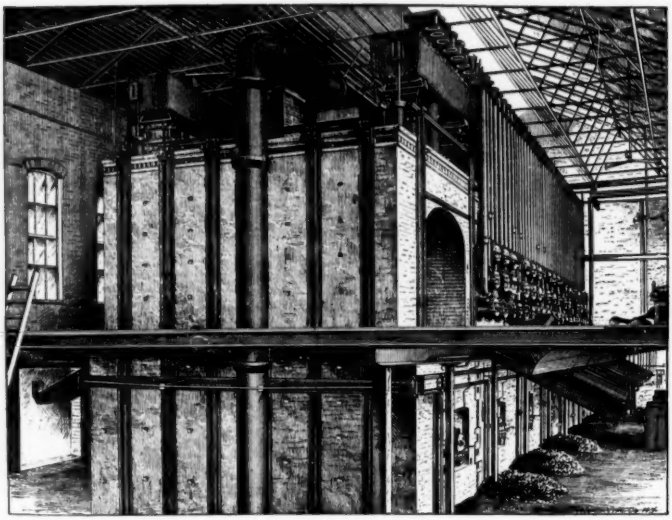
GAS-RETORTS UNDER PROCESS OF ERECTION.

the plant used at the beginning of this century, or to note the many changes which have been made in the apparatus since that time. Let us rather pass to a general description of the process.

Concisely, the fundamental principle of the coal-gas process is to distill bituminous coal—preferably of high grade, rich in volatile matter, and free from sulphur—in retorts highly heated and hermetically



VIEW OF MODERN GAS-RETORT HOUSE WITH FURNACES BELOW FLOOR.



MODERN GAS-RETORT HOUSE—GENERATOR-FURNACES BELOW FLOOR.

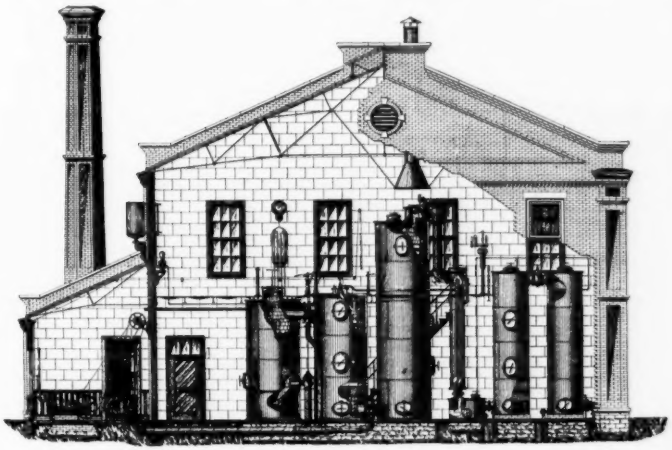
sealed to prevent the coal from coming into contact with the air while undergoing distillation. The gas is led off from the retorts to the various apparatus, there to be treated for the removal of the different impurities and so be converted into a merchantable article. Much care is necessary in the selection of a coal for gas-making purposes. It must have a high percentage of volatile matter, which means that it must contain a large amount of gas; it must be comparatively free from sulphur; it should contain but little moisture; and the residual coke should be fairly hard and yet free from iron. The following analysis may be taken as fairly representative of the American gas coal:

Fixed Carbon.	Volatile Matter.	Ash.	Moisture.
62	34	3	1

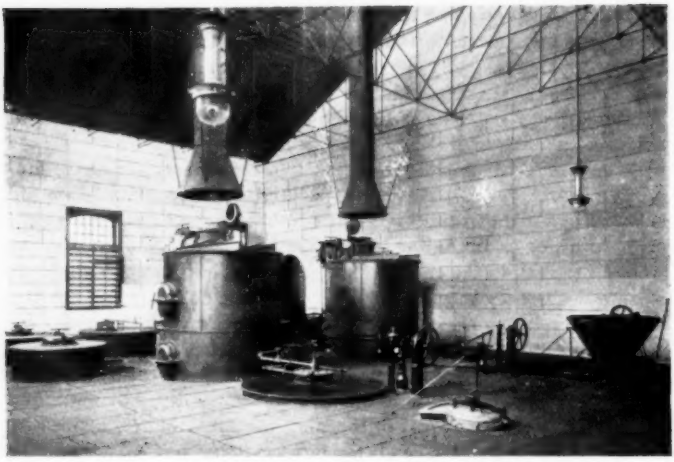
The initial process of the manufacture takes place in the retort, which may be made of iron or fire-clay. As a matter of fact, the iron retort would not be suitable for the practical manufacture of gas as now carried on, for that material could not withstand the great heats to which they are nowadays subjected, but originally they were made entirely of iron. Indeed, as then manufactured, they might be considered as iron pipes, closed solidly at one end and having a lid to be applied at the other end, so secured as to prevent air from getting into

the retort, or gas escaping therefrom. The retort now in use, while embodying the same idea, is made of fire-clay, the inside dimensions varying, though generally about 14 inches high and 26 inches wide and say 9 feet long. In shape they are very much like the letter D in this position : ⊐ . The walls of the retort are generally about 3 inches in thickness, and it weighs about 1800 pounds.

A number of these retorts are built into a large oven, made of fire-brick, about 7½ feet wide and 8 feet high, and are heated by a fire below ; the whole constituting what is technically called a "bench" of 3s, or 6s, or 9s, according to the number of retorts in the oven or arch. Attached to the ends of these retorts are cast-iron mouthpieces, so called, made to receive the lid and leading-off pipe for the gas. When such a bench has had a fire in it for about a week it is ready for gas-making. As the retorts are of fire-clay it is necessary to heat them up slowly ; otherwise they would crack. It is hardly necessary to say there is no fire in the retorts themselves. The heat comes from the furnace in the lower part of the arch, this fire being maintained by the use of coke or coal, and the furnace-gases play all around the retorts before escaping up the chimney. When the retorts are ready for operation, the color of the retorts should have passed beyond red to orange, indicating a temperature of about 2000° F. The coal is put into the retort, or charged, as it is technically called, by means of two scoops made of iron, about 8 inches across the top and ∪-shaped and the door fastened on and made tight, generally by means



GENERATOR-HOUSE—DOUBLE SUPERHEATER SYSTEM.



VIEW OF OPERATING-FLOOR OF WATER-GAS GENERATOR-HOUSE—DOUBLE SUPERHEATER SYSTEM.

of luting, which is a sort of mortar, made from river-mud and lime. Now the process of distillation or carbonization commences. The heat from the furnace beneath causes the coal to break up, distilling off the gas and tar, the latter in the form of vapor. During the first two hours the process of gas-making goes on very rapidly; then it gradually slackens off until, at the end of four hours—the usual period of distillation under proper conditions—the coal has parted with all its gas and it is no longer coal, but coke; it is then drawn from the retorts by the aid of long iron rakes, and, falling into barrows, is wheeled away to be quenched; or a portion of it is drawn direct from the retorts into the furnace below, to continue the process of distillation, and the retorts re-charged with coal.

This fire is necessarily kept going night and day, Sundays and other days. These benches are built in various designs and sizes. Originally only one retort was set to a bench; that is, a fire heated only one retort, and now in small works they often put but three in a bench; however, in ordinary-sized works five or six is the more common number, and in very large works we find nine retorts over one fire. In the latter case the fire is generally run on the generator principle, which is a modification of the Siemens furnace. In the ordinary fire all the air necessary for combustion is delivered beneath the fire-grate and the fuel is thus burned at once to carbonic acid, but in a generator-furnace only half the requisite air is allowed to pass through the fuel,

thus producing carbonic oxid ; then a supplementary quantity of air, heated by passing through channels contiguous to the waste-gas flues, is delivered above the fuel, thus burning the carbonic oxid to carbonic acid, as in this case the combustion takes place well up among the retorts, and as the quantity of air to be admitted can be better graduated the results are much more economical and efficient. In an ordinary bench a retort will burn off about 250 pounds of coal in four hours, and, as the coal will produce about five feet of gas per pound, this means that a bench of six retorts will make about 45,000 feet of gas per day. A portion of the residuary coke is burnt in the furnace, this proportion varying from 25 to 40 per cent. of the coke produced. The retort-house of a manufacturing plant is made up by duplicating this bench as many times as may be necessary to meet the requirements of the city or town, and, in calculating the necessary number of benches, it is usual to allow a margin of about 25 per cent. over and above the requirements of the longest December nights, to permit of repairs. These retorts last from a year to a year and a half, when it is necessary to tear down the setting and refill the arch with new retorts.

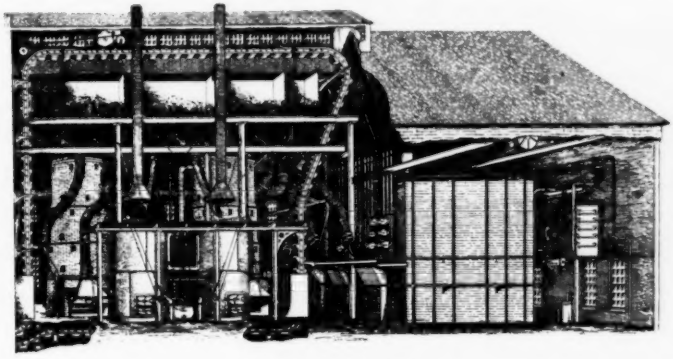
As the gas passes away from the retorts up the take-off pipe, it has a temperature of about 150° F., and is largely charged with tarry vapors and contains many impurities, as ammonia, sulphuretted hydrogen, carbonic acid, and sulphur compounds, which must be eliminated before the gas can be distributed for general use. As the gas is not benefited by being kept in contact for a long time with the highly-heated retorts, and as the walls of the same are somewhat porous, a rotary pump or exhauster, as it is technically called, is used to draw the gas away from the retorts as rapidly as produced. Then the gas passes to the condensers, large iron machines wherein the gas is caused to pass through pipes surrounded by cold water, and as the gas is thus cooled the tarry vapors gradually condense into drops and fall away from the gas. This process is continued until the temperature of the gas is reduced to about 60° F., when the tar will have been practically disposed of. The gas then passes to a scrubber or washer, where it is brought into intimate contact with water. Sometimes these are built in the form of high towers, and are filled with wooden trays or grids. The gas enters at the bottom and water is distributed at the top ; thus the ascending gas meets a continuous stream, or rather a large number of streams, of water. Then again they are built in smaller proportions and the gas and water are brought into contact by mechanical means ; and, as a strong affinity exists between the water and ammonia, the latter gas is absorbed by the former and the gas passes along, freed from this impurity ; the water flows off from the apparatus, as ammoniacal liquor, the source of aqua ammonia, sulphate of ammonia,

SECTION OF WATER-GAS PLANT.

etc. Then the gas is passed through lime, to remove the carbonic acid, after which it is brought into contact with oxid of iron—iron borings which have been oxidized—for the removal of the sulphuretted hydrogen and sulphur compounds. The vessels in which this process takes place are called purifiers, of which a gas-works has generally from four to six, the gas passing through all, save one, in succession. The purifiers contain trays or grids, made of slats upon which the purifying material is placed, and the gas, entering at the bottom of each of these boxes, rises up through the lime or iron and then passes off by the outlet-pipe to the next box, till it has traversed the series, when the operations of purification are supposed to be completed. The idle box, meanwhile, has been filled with fresh purifying material and made ready to be brought into action when one of the other boxes has become foul; that is, when the lime or iron has absorbed all the impurities it can hold. The gas then flows on to the station-meter, from which is taken the hourly record of the gas made. After this treatment we have, as the final product, an illuminating-gas of the following composition, stored in the gas-holders, ready to be sent out as required:

Illuminants	6.	per cent.
Light carburetted hydrogen	37.	"
Hydrogen	50.	"
Carbonic oxid	5.5	"
Oxygen, nitrogen, etc.	1.5	"
Total	100.	

Let us now turn to the consideration of the water-gas process. To



(WILKINSON PROCESS)*

give merely a list of the various water-gas patents would absorb all our remaining space, and, moreover, would be found very dry reading; therefore, instead of attempting anything of this nature, we will take up only with those schemes which show the fundamental principles underlying the general water-gas process andwhich are more or less typical of the others. The scheme most used to-day is that known as the Lowe double superheater plan, the fundamental principle of which was patented by Professor T. S. C. Lowe, September 21, 1875. What might be called the first practical water-gas works were built by the inventor, in Phoenixville, Pennsylvania, in accordance with this patent, but, though in principle the same as the process now so extensively used, the general arrangements and mechanical details have undergone so many changes as to make the final product of scant resemblance to its original predecessor. But the principle is the same, namely, breaking up steam into its original elements by passing it through red-hot carbon and then giving this gas illuminating value by mixing therewith a rich oil-gas.

By reference to the plate on page 231 the general arrangement of the apparatus will be readily grasped. To the left is the generator,—a cylindrical vessel made of boiler iron or steel and lined with fire-bricks, of varying dimensions to suit the quantity of gas required, but generally about 6 feet in diameter and 13 feet high. Next to this comes the carburetter, of like construction and size, but filled by loose fire-bricks, laid in checker-work style; and then follows the superheater, which differs from the latter apparatus only in being about eight feet

* Capacity 1,000,000 cubic feet per diem. Erected for Milwaukee Gas Light Company, Milwaukee, Wis., in 1890, by Bartlett, Hayward & Co., of Baltimore, Md.

higher. Beyond the superheater are the washer and condenser, which are similar to such apparatus in the coal-gas works, though of smaller proportions.

In operating this plant the generator is filled with coal or coke, and, the fire being started, the whole mass of fuel is raised to bright incandescence by the aid of a blower which produces a forced draught or blast. After the apparatus is once heated the length of time the blast is kept on is usually ten minutes. It will be seen that the blast comes in at the bottom of the generator and is forced up through the mass of fuel, then passes by a fire-brick-lined pipe to the top of the carburetter and is forced down through the checker brick-work to the bottom, where it passes into the superheater, and, after traversing the brick-work in this apparatus escapes by the smoke-stack at the top. The blast-gases, in passing through the hot fuel, are raised in temperature, and subsequently impart this heat to the checker brick-work in the carburetter and superheater. It will also be noticed that each of the latter two apparatuses is supplied with a supplementary blast-pipe, and it is made use of in this way: if the valve which admits the forced draughts to the generator were opened to its full extent, practically all the fuel would be converted into carbonic acid, but if the full quota of air is not admitted at this point, the coal will be converted into carbonic oxid. When this gas passes over into the carburetter and superheater, and meets a further supply of air at these points, the carbonic oxid is burnt to carbonic acid, and in this way the checker brick-work therein is raised to the desired temperature. After these operations have been going on for ten minutes the air-blast is shut off, the valve on top of the superheater is closed, and steam is admitted beneath the fuel in the generator, and, this being in a state of active incandescence, the steam is broken up or dissociated by the red-hot carbon of the fuel and is resolved into its original elements, hydrogen and oxygen. The former passes along unchanged, but the oxygen unites with the carbon of the coal or coke and forms carbonic acid, and the latter, continuing in contact with the hot fuel, absorbs another quota of carbon therefrom and is changed into carbonic oxid. Hence, theoretically, the gas as it reaches the top of the generator is composed of equal volumes of hydrogen and carbonic oxid.

In practice, some carbonic acid will also be found present, but it is the object of the gas-maker to have as little of this gas as possible, as it is inert and detracts from, rather than adding to, the value of the flame. This gas is what is generally known as a crude water-gas; that is, it could give some heat but no light. To impart the lighting quality to the gas, oil is admitted under pressure at the top of the carburetter, either by small pipes or by an injector, and

as the oil drops on the heated brick-work it meets the stream of hot gases—the hydrogen and carbonic oxid—coming over from the generator, and is thereby vaporized; the further passage through the hot carburetter and superheater converts the oil vapor into a fixed gas, and it passes down through the pipe to the water-seal or water-valve. In its passage it gives up some of its heat to the oil, and then continues along to the washer and condenser. The operations beyond this point are the same as in be the coal-gas process, so need not further described. When this gas-making process has gone on for ten minutes, the oil and steam are shut off, the valve on top of the superheater is again raised, and the operation of "blowing" up commences, so the process continues ten minutes for blowing up the apparatus and getting the checker-work hot, then ten minutes of gas-making. This process is typical of the class known as the internally-fired superheater, in that the heating is all done inside, and not from the outside, as in the coal-gas process. It will be noted the gas here made is a combination of a non-luminous or crude water-gas and an oil-gas. This is quite clearly shown by the following analysis of the gas as distributed from the works:

Illuminants	14.	per cent.
Light carburetted hydrogen	20.	"
Hydrogen	37.	"
Carbonic oxid	25.	"
Oxygen, nitrogen, etc	4.	"
Total	100.	"

In reference to the differences in the two processes it is well to note that the apparatus here shown takes the place merely of the retorts in the coal-gas scheme. The apparatus shown is the foundation scheme of all the cupola superheater plans.

We may take the Wilkinson process as representative of another type of water-gas apparatus. In this case the initial process is the same,—that is to say, a crude water-gas, composed of hydrogen and carbonic oxid, is produced in a generator which is usually made about 8 feet in diameter and 15 feet high. As in the generator previously described, there is an opening on top for the admission of coal and air-tight doors at the bottom for clinkering. In the running of the apparatus the blast is put on for ten minutes, after which, the fuel having been raised to incandescence, the steam is admitted at the bottom and the process goes on as already described. At the end of five minutes the steam is shut off from the bottom of the generator and is admitted at the top; the gas for the remainder of the time is taken off from the bottom of the generator. At the end of the ten minutes

the blast is again put on, and so the operations are repeated. From here the gas—still the crude, non-luminous water-gas—passes through the condenser and then to a small holder; from there, the gas is brought back by an exhauster or rotary pump to the "illuminator"; the object of this machine is to impart luminosity to the gas by causing it to take up the vapors of naphtha. The illuminator of common size, capable of taking care of 500,000 feet of gas a day, is $3 \times 10 \times 10$ feet, and is divided by inclined horizontal shelves on which steam-coils rest.

Naphtha is admitted at the top of the machine and flows from shelf to shelf. The heat from the steam-coil vaporizes the naphtha and this vapor is taken up by the entering crude water-gas. From the illuminator, the mixed naphtha vapor and water-gas pass to clay retorts similar to those already described, in connection with the coal-gas process, and, these being highly heated, the naphtha vapor is converted into a fixed gas. After this, the gas passes through condensers and purifiers and is then ready for distribution.

By either of these processes a high-candle-power gas can be made, and herein lies one advantage water-gas possesses over coal-gas,—namely, its increased brilliancy. Coal-gas generally runs from 17 to 19 candles: that is, five feet of gas would, during an hour, give the light equivalent of 17 to 19 standard candles, whereas water-gas will run from 20 to 30 candles or even higher. Another advantage, from the manufacturers' standpoint, is the increased quantity of gas which may be made per unit of floor-area, which, with water-gas, is about four times more than with coal-gas.

A misconception exists on the part of some in regard to the heating-power of the crude water-gas,—that is, before the admixture of the oil-gas,—and, working on these wrong ideas, attempts have been made to distribute this non-luminous gas solely for heating purposes, but they have not been successful for the reason that the hydrocarbons which come from the oil impart not only light, but heat as well. Thus the luminous water-gas will have a heating power about the same as coal-gas, namely, 650 to 750 heat-units per cubic foot, whereas the crude water-gas will have only about 290 heat-units. It will thus be seen that even for the purpose of obtaining heat a crude and non-luminous water-gas would have to sell at 60 cents to give the same amount of heat as could be obtained from the luminous gas at $1.40.

It is often asked what is the relative cost of coal-gas and water-gas, and a vast amount of misinformation has been published on this point. Exploiters of apparatus have dwelt on the fact that the gas is made from water, and, since water is cheap, the cost of the process is slight. This is certainly playing with words. It is true that the hydrogen

and part of the carbonic oxid come from the water or steam, but it is also true that a great deal of energy is required to wrest these elements apart when existing in the form of steam or water, and energy costs money. In the coal-gas process energy is required to force the coal into its elementary constituents. In like manner energy is called for in the water-gas process, and whether one scheme or the other is the cheaper will depend upon the locality. It is impossible to lay down any rules for general guidance on this point. The factors are the cost of bituminous coal, anthracite, oil, and the figures a company can obtain for the residuals from the coal-gas process,—coke, tar, and ammonia. The quantity of gas to be obtained from a ton of coal is much more with water-gas than coal-gas—in the one case 45,000 feet against 11,000—but in the former instance 200 gallons of oil would need to be used with the ton of coal.

There was a time when great competition existed between the advocates of the coal-gas process and the water-gas process, and many violent statements were made on either side respecting the value of one scheme and the evils of the other. We were told that coal-gas was a relic of by-gone days,—a scheme suited to the early days of the century, but not up with the push and enterprise of its closing years,—and that the water-gas, being more free from sulphur than coal-gas, and requiring less air for its combustion per unit of light than coal-gas, was more suitable for domestic use.

On the other hand, we heard the assertion that water-gas was not a homogeneous gas, that it varied in candle-power, that it contained tarry vapors, and was more harmful when escaping unconsumed. Now that the smoke has cleared away, we can see more plainly the advantages of each system; we can see that a process is not necessarily obsolete because it was used by our fathers; we can see that, by the improved apparatus now in use, water-gas can be made as stable, as uniform in candle-power, and as free from tar as by any other scheme, and that, all things considered, one gas is as well adapted to domestic use as the other.

As the question is studied more and more, we find that the proposition changes, and, instead of reading water-gas *versus* coal-gas, we read water-gas *and* coal-gas, for we find the modern gas-works does not confine itself to one process, but, by adopting both and utilizing the advantages offered by each, produces a gas which has no equal the world over.

THE STORAGE BATTERY AND ITS USES.

By Townsend Wolcott.

THE storage battery has become an important factor in the field of industrial electricity, and the popular interest therein is steadily growing. It is frequently asked, what is a storage battery and wherein does it differ from an ordinary battery? The several current names for the same thing—storage battery, accumulator, and secondary battery—have been severally objected to by different critics as being inaccurate. The name storage battery is designed to describe the apparent fact that electricity may be stored in the cells and drawn out again at pleasure. The name accumulator is nearly equivalent, and points to the same fact or supposed fact.

These names are not strictly accurate, since electricity is not really stored but simply passes through the battery, causing a chemical change therein which, when it is reversed, is capable of furnishing another current in the reverse direction. That is, the chemical condition of the cell during the discharge tends to reverse or undo what was done during the charge. The use of these names is justifiable, however, on the same ground as that on which we justify the use of the word sunrise.

The name secondary battery indicates the fact that the battery is not active when first made, but only after it has been acted upon by some primary source of electricity. But as it is possible—though perhaps not practicable—to make the battery at once active, a better name would be reversible or recuperative battery, as it can be repeatedly exhausted and revived. This latter property constitutes the chief difference between storage batteries and ordinary voltaic batteries, or primary batteries, as they are sometimes called. Another difference, entirely unconnected with the regenerative principle except by mere coincidence, is the fact that several regenerative cells have been already produced which possess a power of delivering current out of all comparison with any primary cell yet invented. The great power of storage batteries gives them an importance, from an engineering and industrial standpoint, far greater than that of any primary battery.

Important as it now is, the storage battery may be traced to a very obscure orgin. In 1801 Gautherot, a French scientist, while using a voltaic battery with silver-wire electrodes to decompose saline water, noticed that, upon disconnecting the battery, the vessel containing the saline solution and the silver electrodes was capable of furnishing a current of short duration in the direction opposite to the original cur-

rent. In 1803 Ritter observed a similar action with gold wire, and constructed a battery out of pieces of gold separated by disks of cloth moistened with a saline solution. This resembled the pile of Volta, except that the plates were of one metal.

It is worthy of note that this first storage battery should have been made so early in the history of the voltaic cell, for there was a well-directed attempt to practically utilize the reverse current phenomenon, which received the name of polarization. Years after this polarization was a great source of annoyance in primary batteries. After a primary battery had been in operation for a time a marked falling-off in the electromotive force (or intensity, as it was then called) was observed. This was found to be due to the collection of hydrogen gas on the unattacked electrode, and in 1836 Daniell invented the well-known sulphate-of-copper battery, which evolves no hydrogen but deposits copper on the copper electrode.* As there is no change in the surface of the electrode there is no polarization, and this was the first depolarized battery. Polarization was also an evil to be overcome in the solutions used for the electrodeposition of metals.

From the times of Gautherot and Ritter to 1860 there were some discoveries in the direction of the modern storage battery, but in the last-mentioned year Gaston Planté brought out a cell which was the beginning of the practical storage battery. This cell consisted of two sheets of lead, separated by a cloth and rolled into a cylindrical form. The roll was placed on end in a jar of dilute sulphuric acid, and charged, first in one direction and then in the other, with intermediate discharges. After this treatment had been repeated a great many times the chemical action penetrated deeply into the plates and increased the storage capacity in a corresponding degree.

This "forming" process, as it was called, was tedious and expensive, and to obviate the necessity for it Camille A. Faure, in 1881, used a layer of lead oxids spread over the surface of the plates. This layer of oxid was converted by the action of the current on one plate into peroxid of lead, and on the other into metallic lead in a spongy or porous condition. The active material, as these layers were called from the fact that they constituted the portion of the cell which furnished the current, had to be held in place by felt diaphragms or partitions. It will be observed that this construction differs from that of Planté only in starting with ready-formed oxid of lead.

One of these cells was sent from Paris to Glasgow and was examined by Sir William Thomson, who considered it a wonderful advance

* This is the usual statement, but, according to Tommasi, the principle was discovered by Becquerel, in 1829, and Wach in 1830. It does not appear, however, that either of these investigators appreciated the full value of the combination as a depolarized cell as did Daniell.

T. W.

in battery-construction and stated that it contained 1,000,000 foot-pounds of energy.

This certainly was a large amount of energy for one cell of storage battery to contain, especially at that time, but as compared with the energy stored in coal it is small,—not greater than the amount of energy utilized from one pound of coal by a good steam-engine. The interest in the storage battery excited by Sir William Thomson's favorable report gave it an impetus so great that its practical use may be said to date from that time.

The next improvement was to use a perforated plate (or "grid"), which appears to have been invented by G. Philippart, though it was patented in France by E. Volkmar. Philippart filled the perforations in his plate with finely-divided metallic lead, but the results were not so satisfactory as those afterward obtained by using Faure's oxid paste to fill the grids. Sellon used an alloy of lead and antimony for the grids, instead of pure lead. These combined inventions have since been known as the Faure-Sellon-Volkmar system.

There are now in use two types of storage battery which far outnumber all others. One consists of grids filled with Faure's paste, and the other of modified Planté plates. The merit of the grid is that it holds the oxid so that felt or other diaphraghms are unnecessary. In the improved Planté cells the diaphragms are likewise dispensed with. The storage battery thus improved is much simpler than any good primary battery. There is a series of flat plates alternately positive and negative, the number of negatives being one greater than the number of positives, so that the series begins and ends with a negative. These plates are insoluble in the acid, and not visibly altered by charging and discharging the cell. The liquid is dilute sulphuric acid alone, while most primary batteries that are at all powerful have two liquids separated by a porous jar.

The insolubility of the plates and the absence of partitions permit of close packing of the plates, and a consequent improvement of the cell in two respects: (1) economy of room and (2) decrease of internal resistance, both from the diminished distance and increased plate-surface, the resistance of a good cell of moderate dimensions being only a few thousandths of an ohm. This low internal resistance brings the storage battery into some sort of reasonable comparison with dynamos of the same output, a position which primary batteries have never approached.

The chemistry of these lead-lead-peroxid cells is, roughly stated, as follows: Upon discharge the peroxid plate loses oxygen, and the spongy lead plate gains oxygen in equal amount. The protoxid (litharge) formed by the partial oxidation of one plate and partial de-

oxidation of the other plate is converted into sulphate of lead, at least partially. Upon recharge these reactions are reversed. These are the reactions which are available for the storage of energy. There are other reactions, such as the throwing off of bubbles of hydrogen gas upon charging which simply represent waste electrolysis.

The fact that nothing passes from plate to plate but oxygen, and no solid is dissolved and redeposited, is a great advantage, to which may be added the advantage of a comparatively constant composition of the electrolyte. The acid is simply weakened upon discharge, owing to the formation of the sulphate of lead, and restored upon recharge owing to the decomposition of the sulphate.

The spongy lead plates may be replaced by plates of metallic zinc, with the result of a marked increase of electromotive force; an increase from an average of about two volts to about $2\frac{4}{10}$ volts, according to the state of charge. But the solid zinc has to be dissolved and redeposited, which for a long time caused a great deal of trouble owing to the fact that it redeposits in warty, irregular masses. This difficulty has been partially obviated, but in any event the plates have to be set farther apart. The electrolyte also passes through a much greater change. In the fully-charged cell the electrolyte is sulphuric acid; in the fully-discharged cell it is sulphate of zinc with no free acid, as it is necessary to have an excess of zinc in order to prevent the complete destruction of the electrode.

The combination of peroxid of lead and zinc for a primary battery is very old. Wheatstone used it in 1843, and several others soon after. The first serious attempt to use it as a storage battery seems to be due to d'Arsonval and Carpentier, who took out a patent therefor in France in 1879. This type of battery has probably reached its highest development in this country through the labors of William Main.

There is another type of storage battery of commercial importance, known as the alkaline accumulator. The names connected with its introduction in France are Lalande, Chaperon, Commelin, Desmasures, and Bailbache, and in this country Waddell and Entz. The battery consists of zinc and copper electrodes, in caustic alkali. The zinc is dissolved and redeposited, and the copper oxidized and deoxidized. The chief merit of this battery is in its light weight in proportion to its output. The current output per pound weight is very large, but the electromotive force is only $\frac{7}{10}$ or $\frac{8}{10}$ of a volt, so that the power output is much less in proportion, as compared with lead batteries.

When Planté's experiments were new, and again on a larger scale when Faure's "marvelous box of electricity" was announced to the public, the hopes of electricians and others interested in the matter

were raised to a high pitch in regard to the possible uses to which storage batteries might be put. These hopes have not by any means been realized, and in some quarters the storage battery is regarded as being in large measure a failure, and even where it is not so regarded it is generally blamed for all unfulfilled promises.

Than this nothing could be more unfair, for two reasons. First, in the United States at least, the storage-battery business has been largely in the hands of speculators with insufficient capital, no technical knowledge, and no desire to employ technical talent, the sale of stock being considered as an ultimate end. Second, as the storage battery is only one element in a complete plant for generating and storing energy, the battery should not be blamed, as it frequently has been, for the fault of the rest of the apparatus. For instance, the largest schemes proposed, in which a part was to be played by storage batteries, were for the utilization of wind- and tide-power. As to the wind-power question, specifications have been published of windmill-battery plants which would cost more than $1000 per horse-power, estimated on the normal full-load capacity of the windmill. In most localities this cost would be much increased, if estimated on the average steady horse-power which could be delivered for ten hours daily, on account of the uncertainty of the wind. But even if this first cost were not too high, or if the windmill cost no more per horse-power to install than a steam-plant, the conditions under which the battery would have to work would be most unfavorable.

The most favorable condition for the operation of storage batteries is regularity of charge and discharge, and especial attention should be paid to recharging soon after discharge, as the batteries deteriorate rapidly if allowed to remain long discharged. On the other hand, they may remain for considerable periods when fully charged, without harm. The very nature of wind-power would leave a large chance of the battery being caught in a calm in a discharged condition, unless there was an enormous storage capacity in proportion to the daily consumption, which would again raise the question of prohibitory first cost.

An intermittent power, with a regular or approximately regular period which can be absolutely depended upon, furnishes the most favorable condition for the utilization of storage batteries. Such a power is contained in the tides, but no one has yet extracted it. That is to say, the tide-motor which will furnish a really cheap power has not yet been produced. There seems to be no genuine advance on the ancient method of damming up water at high-tide and using it as the tide falls. Such tide-power is not always cheaper than steam-power, and, in these days of improved steam-engines, engineers are

becoming more and more conscious of the fact that it takes a very good water-power to furnish energy more cheaply than a steam-plant on a large scale. Given a really cheap power from the tides, the storage battery undoubtedly could handle the regulating part, which is all that it should be expected to do.

But there are cases where the storage battery has already proved a success, technically, and commercially. In central stations devoted chiefly to lighting, the load is of course nearly all during the dark hours, as day-lighting, except in large cities, is little or nothing. The usual practice is to sell power as well as lights and so to run the plant through the twenty-four hours, as the call for power is chiefly during daylight hours. Nevertheless, there is a considerable fluctuation in the load-diagram in most stations, and a consequent opportunity for the advantageous use of storage batteries.

Where a station runs only a portion of the twenty-four hours, for lighting alone, there is generally a maximum load some time after dark and before midnight. It is usual for some lights to be turned off at 10 P. M., others at midnight, etc., while some burn all night. In many small stations there are only a few all-night lights, and the station has to be kept running for these few, whereas they might be easily run from storage batteries which could be charged at such times as the load permitted while the dynamos were running. As the load decreases late in the night the surplus energy of the dynamos may be turned into the batteries until they are fully charged and the remaining night's work within their capacity. Then the power may be stopped until the next evening, and the batteries partially charged while the load is light.

Where a station runs during all of the twenty-four hours the batteries may be charged during the hours of light load, and discharged so as to assist the dynamos during the intervals of over load. Of course any plant will earn a larger dividend on the investment working all the time than when only working a portion of the time, provided the average load is high enough in proportion to the extra operating expenses, but even then it pays to keep the load at times as near the average as possible. In stations which do not run all the twenty-four hours, it will frequently be found that the average load is enough below the load at which the apparatus gives its best efficiency to allow of considerable saving by shortening the hours and reducing the operating expenses as outlined in the foregoing case.

The modern steam-engine, as constructed for driving dynamo-machinery, is a very admirable machine, and gives, under reasonable fluctuations of load, a high efficiency, and, under violent fluctuations of load, a very close regulation of speed. It is too much to ask, however,

that an engine should also give a good efficiency under these violent fluctuations, as the regulation is accomplished by admitting varying amounts of steam to the cylinder at each stroke, and high efficiency can only be obtained by using steam very expansively.

It has been proposed therefore, to supplement the engines and dynamos of trolley roads with storage batteries to be used after the manner of fly-wheels. In this service they could undoubtedly be made useful, but the larger the road the more load averages up, which would seem to indicate that the larger loads would have no use for batteries; still an examination of the load-diagrams of many fairly large roads shows that there is room left for improvement in the way of evening up.

One of the chief hopes of storage-battery men was street-railway traction,—of all uses to which it could be put the most trying. So far it has not been a marked success, though in the easier service of European cities it has been to some extent successful. The most characteristic feature of street-car propulsion, especially under the usual conditions in America, is the enormous power required, especially in starting, in proportion to the seating capacity of the cars, it being in some cases many times greater than for steam-railways. It is the ability of the electric motor when supplied from a trolley-line to supply this extraordinary demand for power which has made the trolley principle such a wonderful success in so short a time, and in many cases where steam locomotives would have failed to furnish sufficient propelling power had they been allowed to make the trial.

It is not reasonable to expect that we can charge a storage battery from a dynamo and then drive a motor from it without a loss in conversion greater than the line loss in the case of a trolley system, except under extraordinary circumstances. The more conservative battery-men, therefore, have never expected to rival the trolley on the ground of efficiency, but have confined their field of usefulness rather to special cases,—for instance, where the trolley was objected to, as in the larger cities, and where, as in some suburban traffic, the cars had to travel a long way from the power-house, involving a large line loss and a large outlay for line construction where the traffic was small.

But as the early experiments in storage traction in cities were very unsatisfactory, and as the public grow weary of waiting, the trolley was introduced into city after city, until they are nearly all supplied, and the chances for the storage battery in that line have grown beautifully less. It is usually stated that the storage battery is too heavy for traction purposes, but it is safe to say that weight is not the principal cause of failure thus far. Of course a reduction in weight would be desirable, but there have been trolley cars of the gearless-motor type which weighed more than a battery car complete, having a different

type of motor. The principal cause of failure has been the rapid deterioration of the cells in this class of work where the demand for current fluctuates frequently and rapidly, between nothing and the utmost capacity of the battery. It is a question of bookkeeping pure and simple, of how much can be paid in any given case for the renewal of cells without eating up the profits. As the manufacture of batteries is improving and their ability to stand hard usage is increasing, the cause of storage-battery traction is looking up.

In another branch of propulsion, where the demand for power is more moderate, the storage battery is a pronounced success. This is the propulsion of small boats, or electric launches, as they are called. In fact, one of the earliest practical applications of the storage battery was for this purpose.

There are numerous uses for storage batteries on a small scale. Any portable apparatus in which primary batteries are commonly used may be operated by storage batteries to advantage if the proper facilities for recharging are at hand. For the electric-lighting of railway trains they have given perfect satisfaction, and on a smaller scale they have been used for coach-lights. Thus it will be seen that while the storage battery has not yet succeeded to its estate, it has a wide and promising future, where in its legitimate applications it is likely to make manifest its virtues which, if wisely directed and properly applied, will make it one of the most useful accessories to modern dynamo electrical machinery.

MEASUREMENT OF THE ELECTRIC CURRENT.

By Nelson W. Perry, E. M.

WHAT, measure an invisible, intangible, imponderable something whose exact nature we confess we do not yet understand? Yes, and measure it more exactly and more easily than we can coal or heat or light. Though it is invisible we may measure it by its appearance; though intangible we may measure it by its touch; though imponderable we may measure it by its weight. We may measure it in quarts, yards, pounds, candle-power, in horse-power, by the thermometer, by cubic feet, and, in fact, in almost any way in which visible, tangible, ponderable entities are measured.

This seems to be a most anomalous statement, but it is nevertheless true. It will be made more clear, however, when it is stated that the methods of measurement are in accordance with the scriptural rule: "By their works ye shall know them." It is not electricity itself that we measure in the units above mentioned, but the results which are produced by this mysterious something when allowed or caused to act in various ways. For instance, it is an axiom that like causes produce similar results. It follows that if we multiply these causes the results will bear some definite relation to the multiplied cause, and, if we can discover what this definite relation is, the first result may be taken as a unit by which to measure the second result. Sometimes this relation between multiple causes and their effects is quite simple while at other time complex, but they have now been so carefully studied that they are pretty well understood. Thus of the simple relations, we now know definitely that the amount of gas liberated in the decomposition of water by the electric current (electrolysis) is directly proportional to the current. Therefore, if one current liberates twice as much gas in a given time as another, we know that the former was twice as large as the latter. In this case, if the smaller current liberated one cubic inch of gas, one might with propriety say that one cubic inch of electricity had passed in the latter and two cubic inches in the former. The amount of a given metal, too, which is deposited from solutions in given periods of time is directly proportioned to those currents, and if this be weighed, current might be considered as measured in pounds and ounces.

As an illustration of the more complex relations between cause and effect, may be mentioned the production of heat in a conductor by a current passing through it. Double the temperature no longer indicates that twice the current is passing, however, for it takes very much

less than double the current to produce double the heat. It has been found that the heating effects of electricity are proportional to the *square* of the currents passing, viz.: that two units of current will produce four times as much heat as one unit, and three units nine times as much. Where electricity is employed to produce light, the relations are still more complex, the illumination varying about as the fifth power of the current. If these relations are perfectly definite we can measure the current in the former instance by degrees of temperature, and in the latter by candle-power.

Of two clocks which normally run synchronously, if one be retarded or accelerated by the passage of a current through a neighboring electro-magnet or otherwise, if we introduce a planetary movement into the clock mechanism, it may be made to revolve a spool or drum upon which will be wound or unwound a tape or string, and when we wish to know how much current we have consumed we may measure it off in yards or inches, or more directly from the clock-dials, in hours and minutes, which are the measure of the retardation or acceleration of one clock over the other.

Thus we may use any of the effects of the electric current which lend themselves readily to measurement as substitutes for their causes and express the values of the currents in any of the units by which the effects themselves are usually measured. In this way we have the choice of an almost infinite variety of metering methods depending upon the well-known properties of electricity.

Among the properties of electricity most usually relied upon to enable us to measure it are—

1. Its property of producing magnetism.

2. Its property of causing a freely-suspended magnet to take up a position at a greater or less angle to the direction of the current.

3. The property of the mutual attraction and repulsion of currents.

4. The suction of a solenoid traversed by a electric current upon a magnetic core.

5. The elongation of a wire due to the heat caused by the passage of current.

6. The electrolytic decomposition of liquids or solutions.

The method of determining results by indirect methods so generally employed in electrical measurements is not necessarily a source of inaccuracy or uncertainty, nor is it unique in exact science. In chemistry, for instance, it is the exception rather than the rule that an element or base is determined directly. The constituent sought is usually precipitated and weighed as a salt of known composition, and, from the weight of this salt, the weight of the element to be determined is obtained by calculation.

Current can be measured either absolutely or relatively. The absolute determinations are exceedingly difficult, requiring the most painstaking care, often extending over months of time. As an illustration of the difficulties of absolute determinatiou it may be mentioned that the committee of the British Association appointed to redetermine the value of the absolute unit of resistance made an error of 1½ per cent., so that the old unit was only equal to .9866 of the new unit. It is a method that should be relegated to the scientist, or rather to a committee of scientists, thoroughly skilled in such work, and has no interest either to the engineer or the lay public. On the other hand, the relative determination is so easy that a lecturer on this subject, Professor Francis B. Crocker, once said he thought that a telegraph-boy, after a short period of instruction, could make a measurement with an error not to exceed one-tenth of 1 per cent., and that a student might do somewhat better after a month's instruction. It is the relative determinations, therefore, with which this paper will deal. The six different properties of the electric current mentioned above, upon which we depend for these determinations, all involve either one or the other of four fundamental principles, viz.: electro-magnetic, electro-dynamic, electro-chemical, and electro-thermal. Upon these four principles depend all the various forms of measuring-instruments.

Of the electro-magnetic instruments, perhaps the best example and the simplest is what was known as the Bergman or Edison amperemeter, which consists of a coil of wire which, when traversed by a current, draws an iron armature within itself as the current increases, and by this motion causes a needle to pass over a dial that has been calibrated from some reliable instrument.

It must be borne in mind that, as in every-day life we have need of hay-scales as well as chemical balances, so we have use for electrical instruments which give but approximate results as well as those of the utmost delicacy. Instruments of the kind just mentioned are the hay-scales of electrical instruments, but they find great use in central stations and electric street-railway power-houses where current is turned out at wholesale and approximations to the amounts only are desired.

One of the great faults of instruments of this kind and one which prohibits their use for more accurate determinations, is that the readings of an increasing current differ from those of a decreasing current. This is due to the iron core which introduces what Professor Ewing calls *hysteresis*, which is the lagging of a magnetic effect behind its cause. That is to say, if the current should suddenly increase, owing to the magnetic sluggishness of the iron core, the instrument would not register quite as high as it should, and, if the current should then suddenly decrease to its former quantity, for the same reason the instru-

ment would not read as low as it should; its reading on an increasing current would be lower than its reading for the same current that was decreasing from a higher value.

The instruments constructed on the electro-dynamic principle, of which the Siemens electro-dynamometer and the Thomson balance are examples, and which depend for their action upon the mutual attraction and repulsion of currents, do not have this defect, since they contain no iron in their construction.

A difficulty presents itself with instruments of this class also. Owing to the fact that the mutual reactions of currents are not proportional to the currents themselves, but to the squares of the currents, the graduations on the dial-plates are not equal for equal increments, but increase very rapidly from very small to very large divisions. They possess, however, the very important advantage, which some classes of instruments do not possess, of being equally applicable to the measurement of both direct and alternating currents.

Under the head of electro-chemical meters come those which depend upon the power of an electric current to decompose liquids and solutions of metallic salts. As they liberate gases by this process, or deposit metals, they are called gas or metallic voltameters. If the former, the gas is usually measured, if the latter, the metal is weighed. The gas voltameters have very little practical interest but the metal voltameters have come into very extensive use. The best-known meter of this class is the Edison meter, which consists of two amalgamated zinc electrodes immersed in a solution of sulphate of zinc. The action of the current is to cause a transfer of metal from one electrode to the other. Since the amount of metal deposited on the one or dissolved from the other is exactly proportional to the current, the gain in weight in the one or the loss in the other is an exact equivalent of the current passing. In order that the whole of the energy of the current shall not be consumed in the operation of measuring it, as would be the case were it all passed through the voltameter, the latter is placed in a shunt circuit whose resistance is so proportioned that it will take off but $\frac{1}{99}$ part of the current. As a means of check, two voltameters are always placed in each circuit in parallel, and since the Edison current is usually distributed by the three-wire system which extends into every customer's house, and which really constitutes two circuits, the Edison meter as installed consists of four voltameters—two for each circuit. In reading the meters for the determination of the bills, a losing zinc of one bottle and a gaining zinc of the other, of each pair, are weighed, the one as a check on the other. Since a change of temperature affects the conductivity of metals and liquids in exactly opposite ways, though in different degrees, a neat method of compen-

sating for temperature is resorted to. This consists in introducing into each bottle-circuit a coil of copper wire of such length that the loss of conductivity of the metallic portion of the circuit by increase of temperature will just balance the gain in conductivity in the liquid portion due to the same cause.

While this meter is capable of giving quite accurate results under favorable conditions, the conditions of commercial use are not such as to make it really an instrument of precision, but it is accurate enough under these conditions for all practical purposes, the range of error rarely exceeding 2 per cent. As indicating into what general use this meter has come, it may be stated that in New York city alone 200,446 16-candle-power incandescent lamps, 2680 arc lamps, and $6117\frac{92}{100}$ horse-power of motors are supplied from 5500 Edison meters. It may be interesting in this connection to show how the bills are made out from this meter after the zincs have been weighed.

One ampere-hour of current will deposit 1.224 grams of metallic zinc. But since only $\frac{1}{96}\frac{1}{5}$ part of the whole current used passes through the voltameter, the amount of deposit which will represent an ampere-hour of current will be $1\frac{22}{96}\frac{4}{5}$. The Edison Company sells current in lamp-hours, viz.: using the amount of current consumed in one hour by a 16-candle-power lamp as its unit, and charges for this 1 cent. A 16-candle-power lamp requires .424 of an ampere of current, therefore the weight of zinc deposited per 16-candle-power lamp-hour will be $1\frac{22}{96}\frac{4}{5} \times \frac{424}{1000}$ and there will be as many lamp-hours for every gram of zinc deposited as the result of the multiplication of these fractions is contained into 1. This may be expressed thus:

$$\frac{1}{1\frac{22}{96}\frac{4}{5} \times \frac{424}{1000}} = \text{number of lamp-hours per gram of zinc deposited,}$$

and this at 1 cent per lamp-hour equals $18.75. This is what is known as the "lamp constant." By multiplying this by the number of grams and fractions of a gram deposited, the customer's bill is determined at once. It is evident that this meter cannot be used on alternating-current circuits.

The thermo-electric methods are not much employed for measuring currents but when used at all are employed to determine the voltage. The Cardew volt-meter is the most familiar instrument built on this principle, and consists simply of a long wire through which the current passes and which by its expansion and contraction due to the changes in the strength of the current actuates an index-needle.

It is usually stated that this meter is equally applicable to either alternating or direct currents but this is not strictly true. It may, indeed, be used for either current if properly calibrated for the current upon which it is used, but an instrument calibrated for direct currents

will not give correct readings if placed on an alternating-current circuit, and *vice versa*, as the heating effects of the two are not alike.

While there can be nothing simpler than the Cardew instrument, it is open to the serious objection that it consumes an enormous amount of current, relatively speaking. While on this subject of the loss of energy in measuring instruments it may be well to refer to some remarks made by Mr. Edward Weston at the meeting of the National Electric Light Convention held at Washington in the latter part of February and the first of March. He called attention to the fact that the losses in central stations due to the consumption of energy in the measuring-instruments sometimes used, when figured out in dollars and cents per annum, was startling, and cited an instance which had come under his observation where the loss in this one item was $89 per year. His remarks attracked wide attention and deservedly so, as this source of loss had been almost entirely unsuspected by most central-station men.

Another class of instruments founded upon the mutual directive action of magnets and currents includes the Weston instruments. In fact the instruments of this make form a class by themselves, for while they employ both iron and magnetism as do the electro-magnetic instruments, they are not subject to the disturbing influences of hysteresis. The magnets in this case are not electro magnets, as in the other case, but permanent magnets, and the operation of the instruments is not dependent upon changing magnetism at all. The Weston ammeter consists of a permanent horse-shoe magnet having suspended between its poles a coil of very fine wire to which the needle is attached. But a very small portion of the current passes through this coil and the deviation of the needle is caused by the variation of the current in this constant magnetic field. Since the angle through which a coil will swing under these conditions is directly proportional to the current flowing through the coil and not as in the electro-dynamic instruments, proportional to the square of the current, the graduations on the dial-plate are uniform throughout the whole range of the instrument. The Weston instrument cannot be used on alternating currents, nor will it register, as some other instruments do, if the current is passed through in the wrong direction. From the fact that it measures but a very small fraction of the current, the losses due to this cause are exceedingly slight. It is also extremely delicate and sensitive, although it is what is called "dead beat," which is to say, that with sudden changes of current the needle does not vibrate much but comes almost at once to rest after registering the new conditions.

The Weston instrument is a device *sui generis* and peculiarly an American product. Mr. Weston himself is an Englishman by birth but intensely American in feeling, and takes pride in the fact that his

instruments successfully compete with the best of foreign make in their own markets. This instrument and those built on the electro-dynamic principle may properly be called the chemical balances of electrical measuring-instruments.

Every electric current involves three elements: (1) the current itself, which is measured in amperes; (2) the pressure or electromotive force which gives rise to the current, measured in volts; and (3) the resistance which the conductor opposes to the current, which is measured in ohms. A current is not fully described, therefore, until all three of these elements are given, so we have instruments for measuring each of them separately. If any two are given, however, the third may be calculated from Ohm's law, which expresses the interrelation of the three, which is that the current that will flow through a given conductor is equal to the electromotive force by which that current is urged along, expressed in volts, divided by the resistance of the conductor expressed in ohms.

Thus far the instruments described are intended for the measurement of the current, and are called ammeters. Instruments intended to measure the electromotive force are called volt-meters. These latter do not differ in any way in principle from the former, and any instrument that can be used as an ammeter can also be used as a volt-meter, provided that only a very small proportion of the current is allowed to pass through it. The volt-meter, therefore, is chiefly distinguished from the ammeter of the same class in having long coils of very fine wire instead of shorter coils of heavy wire. A volt-meter is in fact a very delicate ammeter and might very properly be called a mille-ampere-meter. It is in fact sometimes so used.

Resistances are usually measured by means of an instrument known as the Wheatstone bridge. This is conventionally represented by four wires arranged in the shape of a diamond, with a fifth one, with a very delicate galvanometer in circuit, connecting the two obtuse angles of the diamond. If now the four bounding wires of the diamond have equal resistances and the two acute angles of the diamond be connected to the two poles of a battery, the current will divide, half going around one side and half going around the other side of the diamond, and there will be no tendency for any of the current to pass through the diagonal wire. If, however, one of the two wires on one side has a greater resistance than the opposite wire on the other side, some of the current will pass through the diagonal wire and be indicated by the galvanometer. If we increase the resistance of this opposite wire so that the two are again exactly equal, no matter what the resistance may be, the diagonal current will cease. Therefore, if we place the resistance to be measured in one

leg (as it is called) of the bridge, and add known resistances to the opposite leg until the galvanometer ceases to show the passage of current through the diagonal, we have the exact measure of the unknown resistance. The operation is exactly analogous to weighing on a beam-balance, where the substance to be weighed is placed in one scale-pan and exactly balanced by pieces of iron of known weight placed in the other. While this instrument is of great simplicity, it is also one of great delicacy and precision.

In addition to the preceding, there are a long line of instruments of other kinds such as watt-meters, sine and tangent galvanometers, and indicators of various kinds. One of the latter class which is one of the most ingenious in the whole range of electrical measuring instruments ought to be mentioned. I refer to what is known as the Edison indicator, though for what reason it bears Edison's name I do not know, since he had nothing to do with it. It consists of a Wheatstone bridge in the two opposite legs of which are placed incandescent lamps, and in the other two, balancing coils of German-silver wire; the index-finger being the galvanometer-needle itself. The resistance of the lamps varies rapidly with the temperature, while that of the wire remains fairly constant. If, therefore, the electromotive force on the circuit varies from that for which the German-silver resistances were adjusted, the balance will be destroyed and a current will flow in one or the other direction through the galvanometer, indicating "too high" or "too low." These instruments are much used in central stations to enable the dynamo-tender to regulate the pressure on his circuits.

One of the greatest desiderata in many electrical measuring instruments is a material whose electrical resistance shall not vary with the temperature. For a long time German silver more nearly filled the bill than any other known alloy, but it remained for an American, Mr. Edward Weston, to invent an alloy having a zero temperature coefficient—which means that the electrical resistance of this alloy does not vary at all with increase or decrease of temperature. The credit for this has been usurped by foreigners, but the honor is due to America.

ELECTRICITY

Conducted by Franklin L. Pope.

ONE of the most important electrical power-plants yet undertaken, and one which is perhaps second only to that in progress of construction at Niagara Falls, is that of the General Electric Co. at Portland Ore. The falls of the Willamette river, twelve miles from Portland have a descent of forty feet, with a very large and unusually constant volume of water. The power-house, now nearly completed, is of stone and brick, with a steel-truss roof, and is 420 feet long, and 77 feet from the lower water-level to the eaves. The hydraulic and electrical machinery is divided into twenty different sections, in dependent of each other, in each of which is installed a 42-inch and a 60-inch Victor turbine, coupled directly to a generator of 450 kilowatts capacity. The 42-inch turbines constitute the ordinary, and the 60-inch turbines the emergency, plant. The load will ordinarily be carried by the first-named turbines, which run at a speed of 200 revolutions per minute. The 60-inch turbines are intended for use only during periods of extremely high water, when the smaller ones will be too deeply submerged in backwater to give efficient service. The aggregate electrical equipment has a generating capacity of 9000 kilowatts, or about 12,000 horse-power. An extra section contains two 48-inch turbines, carrying a pair of exciters of 300 kilowatts each, which serve the entire range of generators. The main generators are of horizontal type, and the shafts are supported upon hydraulic bearings of oil, under a pressure of 275 pounds per square inch. The weight of each shaft and its attachments is about 33,000 pounds. An oil-pump, driven by an independent turbine, forces oil into an accumulator which serves to maintain the pressure in the hydraulic bearings. The three-phase alternating system is to be used to convey power to the city of Portland, for use for general purposes.

MR. OSCAR BRADFORD, president of the Bradford Machine Co. (Chicago), writes to the Magazine his impressions, gained during a recent trip through the Rocky mountain region, of the immense force developed by the melting of the annual fall of snow, which, though now entirely wasted, might be made available as a source of energy. The section of country referred to comprises the states of Washington, Oregon, Montana, Idaho, California, Wyoming, Nevada, Colorado, and the territories of Utah, Arizona, and New Mexico. The natural resources of this section, which fit it for the support of an enormous population, have failed to attain a commensurate degree of development, largely on account of the general scarcity of fuel. This want, according to Mr. Bradford, has been compensated for by nature by providing an unlimited water-power, which science has shown us how to utilize in the generation of electricity, which may be made to render service to a large population, thus rendering the lack of fuel a matter of comparative unimportance. On the whole, Mr. Bradford is convinced that the wealth of timber, building stone, precious and other metals, and a soil capable of the highest degree of cultivation with the aid of irrigation, are well adapted to sustaining a large population, to say nothing of the healthful climate, and the absence of cyclones, due to the numerous mountain peaks which serve to break up and scatter the force of clouds and wind.

The annual deposit of snow, which is quite uniform in quantity, owing to the regularity of the moisture-laden trade-winds, melting gradually as the season advances and descending from the great heights of the mountain ranges to the ocean level, creates an inconceivable amount of power, and nature has so shaped the banks of mountain streams that sites for dams, with material for their construc-

tion close at hand, can be found at almost every mile of their length. When, by that process of mental evolution which seemingly demands a certain period of time for the incubation of a new idea, the attention of capital is once attracted to these vast opportunities for profitable investment, and the public starts in its sheep-like way on a westward stampede to enjoy these bounties of nature, it may be a serious question as to the effect upon the eastern states and their long-established industries. What will become of the coal-mines and the capital invested in them? Will the transportation companies be compelled to endure a still further reduction of traffic? Will the makers of stoves and furnaces, steam-radiators, and other accessories of heat by combustion, cease to do business? Will the factories dependent wholly upon steam-power be able to face the competition of falling water, or will they be compelled, together with their operatives, to move westward, to secure like advantages?

THE only hitherto undeveloped water-power of any magnitude on the Merrimac river—that known as Sewall's falls, a short distance above Concord, N. H.—has at length been utilized by the Concord Land and Water-Power Co., for an electric transmission plant for supplying the city of Concord with light and power. The dam is a fine structure of timber crib-work, packed with granite chips, and gives a head of 22 feet, with an average of about 5000 gross horse-power. The power-house is situated at the end of a canal 75×25 feet, and 1000 feet long. It contains five pairs of 39-inch horizontal turbines, set with draft-tubes, having a capacity of 400 horse-power per pair. The power is transmitted from the turbines to the jack-shaft in the dynamo-room by heavy belting, the machinery being provided with clutches, so that any wheel or section may be run independently of any other. Heavy fly-wheels are used to prevent the sudden speeding up of the turbines upon a reduction of the load, before the governors have time to act. Two large tri-phase generators, out of the six which are ultimately to be employed, are already in place and at work. These are separately-excited machines of 250 kilowatts capacity each. Each generator is driven from the jack-shaft by a 36-inch belt at a speed of 600 revolutions per minute. The current is generated at a potential of 2500 volts, and is conveyed directly to the step-down transformers, which are centrally located at a point in the city three miles from the power-house, by overhead copper wires, with a fall of potential of 300 volts. The network of distribution and consumption circuits in the city is worked on a potential of 110 volts at the secondaries of the transformers. The company is at present supplying in Concord about 5000 incandescent and 300 arc lights, as well as 400 horse-power of motors, and about 30 kilowatts for heating, cooking, and miscellaneous uses.

THE efforts of the General Electric Co. to arrogate to itself the control of all the electrical industries of the United States —the avowed policy with which it entered the field some two years ago—has apparently not been attended, thus far, with distinguished success. The annual report recently published shows that the surplus of over $1,000,000 reported a year ago has given place to a profit and loss debit of some $12,500,000, representing the impairment of capital by shrinkage of assets during the twelve months. Nevertheless, among the assets scheduled in the present report is one item of over $8,000,000 of "patents and franchises." It does not appear that these patents and franchises have hitherto seriously impaired the capacity of rival companies to do business in the electrical field, and the prospect of any such consummation hereafter seems to the disinterested observer to be daily growing more and more remote. But in spite of this depressing exhibit, a company which, in such a year as we have just passed through, can show net earnings of $2,250,000 above fixed charges, is by no means in a hopeless condition. The era of reckless speculation and inflation in electric enterprises, though probably not yet at an end, inasmuch as the inevitable crash in the street-railway business is yet to come, is certainly drawing

toward its close. The day is not far distant, when manufacturers of dynamos, motors, and other electrical machinery will have to come down to hard-pan, and sell their wares on their intrinsic merits, and at the ordinary manufacturers' profit, as steam-engines and wheelbarrows are sold. The possibility of any monopoly in the electrical business, except possibly that of some cheaper apparatus or process than any of those now existing, which may hereafter be discovered, has apparently passed away forever.

THE new Atlantic cable which is now being laid in sections between Ballingskelligs bay, Ireland, and Canso, Nova Scotia, for the Commercial Cable Co., is in many respects a notable piece of work. The cable is about 2100 miles in length; its conductor contains more than 1,100,000 pounds of copper, and is armored with over 10,000,000 pounds of steel wire. A considerable portion of the copper is from the Trenton works of John A. Roebling's Sons, and this is, we believe, the first instance in which wire of American make has been used in the manufacture of the conductor of an Atlantic line. The calculated rate of transmission by the new cable is thirty words per minute, which is greatly in excess of that of any of the lines now working, the average speed of which is probably not above eighteen or nineteen words per minute. This increased capacity is due to the great quantity and unusually high conducting power of the copper used in the core. The line is being laid by the *Faraday*, a large steamer constructed expressly for this kind of work, and owned by Siemens Brothers & Co., of London. The heavy shore-ends are to be first laid, 100 miles extending westward from the Irish coast, and 400 miles across the Banks of Newfoundland. These are expected to be completed in time to lay the mid-ocean or deep-sea portion during the fine weather which usually prevails in the north Atlantic during the first two weeks of June. Like all modern cables, the new line will be operated on the duplex system, by which transmission is carried on simultaneously at full speed in both directions.

IN the annual report of the Massachusetts railway commissioners for the current year, an interesting comparison is made between the cost and earnings of the horse-railway systems of 1888 and the electric-railway systems of 1893, as taken from the official returns filed with the commission. The percentage of increase in net earnings is given as follows: per passenger carried, 62.5; per car-mile run, 73.56; per round trip, 85; per mile of railway, 57.44. On the other hand, the percentage of increase in cost of railway per mile is 60.2, and in capitalization per mile 65.2 per cent. The commissioners point out that an increase of 65 per cent. in capitalization, and of only 57 per cent. in net earnings, does not make a very favorable showing for the electric system from a financial point of view. It is also suggested by them that, inasmuch as the electric plants are all new or nearly so, the cost of maintenance chargeable to operating expenses must thus far have been abnormally small, and the consequent exhibit of net earnings abnormally large. Ordinarily this would doubtless be true, but the fact is that two or three or more new sets of motors have been substituted for others within the period under review in consequence of improvements in design, the cost of which has doubtless gone in most cases, into the maintenance account. The standardizing of the electric machinery which is now going on will, in our opinion, tend largely to reduce the maintenance account in future years. It is clear however, that the electric railway offers but little margin for bad management or waste of any kind, if ultimate financial disaster is to be averted.

THE Boston Fire Underwriters' Union insists upon the requirement that every piece of insulated wire which is to be used in that city for conveying electric currents for lighting and power purposes shall be subjected to an insulation test before it can be placed within a building. H. C. Cushing, Jr., in a paper in the *Electrical Engineer*, states that these tests show that it is only within the last two years that uniformly excellent insulated wire has

been attainable. The samples examined since March, 1888, have come from something like fifty different manufacturers, and the records of the tests, all of which have been preserved, have shown a vast improvement in each successive year, as to quality of wire, insulation, finish, and power to withstand abrasion. The samples tested in 1888-89 were extremely variable in quality. Many of them exhibited flaws, pin-holes, and non-homogeneous coatings of insulating material; a state of affairs which is shown by the more recent tests to be rapidly disappearing with the introduction of modern improvements in manufacturing processes. Most of the improvement has been made within the past two years, and the goods of the leading manufacturers are stated to have now reached a degree of perfection considerably in excess of the requirements of the underwriters. Owing to this thorough system of inspection, which insures an electrically perfect wire, there would seem to be no possible chance for a fire to originate from any defect in the conductors, if wiremen and inspectors do their duty in accordance with the present rules and requirements of the Underwriters' Union and of the New England Insurance Exchange.

IT is reported in the newspapers that the Bell Telephone Co. of Canada has brought an action against the Montreal street-railway company to recover $27,000 damages, for expenses incurred in placing return-wires on their lines; the former use of the earth being rendered impossible by the interference caused by the electric railway circuits. The legal contention of the telephone company appears to be that it has obtained, by long usage, a vested right to the use of the earth for the purposes of its business, of which the action of the railway company has deprived it. We do not recollect that this particular point has been settled in any of the somewhat numerous suits between telephone and railway companies which have been litigated in the United States. We imagine that a coterie of gifted attorneys and experts might be able to find a great deal to say on both sides of such a question. If the English doctrine of "ancient lights" is accepted in Canada, we should think it might be invoked as a somewhat powerful analogy in support of the position taken by the telephone company. The case seems likely to be an interesting one, and we may have more to say about it.

THE American Institute of Electrical Engineers has taken a very important step in the formal adoption, at its March meeting, of the provisional magnetic units which have for some time been before it for consideration. This system should not be confounded with that under consideration last summer by the Electrical Congress at Chicago, in which a not altogether successful attempt was made to correlate the proposed magnetic units with the accepted electrical units, by assigning to them arbitrary magnitudes. The severe criticism with which this proposition was met from the best authorities on all sides apparently has had the effect of bringing forward the far preferable system which has now received the sanction of the Institute. The new provisional system certainly seems well adapted to the needs of practical workers, and, although it may possibly have to encounter some adverse criticisms from expositors of pure science, yet if it should be fortunate enough to find favor in electro-technical circles, its ultimate adoption will be but a question of a short time. There was quite a lively discussion among the members of the Institute upon the question of nomenclature, the majority favoring the use of terms derived from proper names, as has hitherto been the accepted custom in reference to electrical units, and the minority contending that Greek derivatives were preferable. Messrs. Houston and Kennelly, in a recently-published communication, have proposed to lessen the inconveniences arising from the small dimensions of some of the units in common use, by employing prefixes to denote large multiples, such as "bega" for million, "trega" for one trillion, etc., and for sub-multiples, "bicro" for one billionth, "trico" for one trillionth, etc. This seems a very sensible suggestion, and we have no

doubt that it will find ready acceptance among electrical engineers.

THE commonwealth of Massachusetts is at present represented, or rather misrepresented, in congress, by one Walker, who, if we may judge from published extracts from his speeches, would be much better off if he were relegated to some retreat for the restoration of disordered mentality. In a recent speech in the house, he railed wildly at the builders and owners of trolley railways, calling them, among other things, "a cruel, heartless, remorseless combination of interests, that has no regard for human life, or the comfort of citizens." Referring to the Westinghouse, General Electric, and other leading manufacturers of street-railway machinery, he asserted that "these great dominant unprincipled combines" had pursued the conduit system of street-car traction "with the malignity of the infernal regions." Not content with this ridiculously false assertion, he proceeded to vilify the electrical engineers of the country—who, we may parenthetically observe, are, as a body, at least as respectable and as respected as the one which is compelled to listen to his own insane outbursts—by making the preposterous assertion that "this monstrous devil-fish has in its pay every electrical engineer of this country, retained in its own cases, who is of sufficient reputation to have his head at all above the common level of electrical engineers; and you cannot get an opinion out of any of them." In reply to this, it may be observed that, if the Westinghouse Company, or the General Electric Company, or any individual electrical engineer could get control of a successful conduit system for electric railways, they would have in their hands "a potentiality of wealth beyond the dreams of avarice." We are afraid that Mr. Walker is a fool.

ACCORDING to the returns of the census of 1890 there are in the United States 313 electroplating establishments, representing a capital of $33,838,549, and employing 2162 operatives. The annual value of the product is $3,121,642.

IN a paper recently published in the *Electrical World* on the transformation of alternating currents, Charles P. Steinmetz contends that, in electrical distribution, anything that can be done by one polyphase system can also be done by any other polyphase system, and in most cases by a single-phase system; hence he argues that in these days there exists no good reason for using polyphase systems for electrical light- and power-*distribution* only, in place of the low-frequency single-phase system, which, by reason of its simplicity and convenience of regulation, he believes to be far superior to any polyphase system. The proper sphere for polyphase systems, in the opinion of Mr. Steinmetz, is in long-distance power-*transmission* at high potentials, in which the tri-phase system offers the important advantage of a saving of copper of over 25 per cent. over the single-phase alternating system, and even this may be increased if the line has been designed to comply with conditions of maximum economy, as pointed out, among others, by Professor George Forbes.

A VERY successful example of the application of electric locomotives to mine-haulage is that in use in the Bear Run mine of the Blossburg Coal Co., in Tioga county, Pa. Two locomotives are now in service, each propelled by two motors, one on each axle, aggregating 30 horse-power. Each locomotive weighs 7500 pounds; is 9 feet 6 inches in length, and stands only 31 inches above the rail. The draw-bar pull is 1500 pounds, and the usual speed about six miles per hour. The track-gage is 36 inches. An 80-horse-power engine drives the generator for supplying the current to the locomotives. A maximum load can be hauled by these locomotives of thirty-two loaded mine-wagons weighing 3200 pounds each, in one place up a 3-per-cent. grade. Each locomotive averages a daily haul of about 650 tons. The substitute of the electric system for the mules formerly employed, has effected a notable economy in the cost of haulage, particularly as the machines occupy so little vertical space that they can go into many headings which were wholly inaccessible by animal power.

RAILWAYS

Conducted by Thomas L. Greene.

THE speculative opinion in Wall street seems to agree with the view expressed by President J. Edward Simmons, in the Magazine for April, that the turn in business affairs had come, and that there is warrant for confidence in the future. Quotations for the very best bonds have been high all winter, but there has been lately a pronounced advance in the prices of bonds and stocks previously considered somewhat doubtful. If any one cause more than another is to be named for this confidence in railway securities on the part of the speculative and investing public, it it the radical reduction made in operating expenses. The public have made up their minds that because of these reductions the railways will continue to pay their old fixed charges or dividends until the gradual resumption of business activity shall enable them to return to their old-time expenditures. To business men and others dependent directly or indirectly upon the prosperity of the railway for their own trade and profits, it may seem at first as if this later and further reduction in expenses was an additional blow to them. While this may be true for the moment, it is nevertheless a fact that in no other way could their trade with the railways be secured for the future. Railways are dependent for future improvements on their credit. The recent advance, therefore, in the quotations for their stocks and bonds is an assurance that the capitalists of the country have a returning faith in them as business enterprises. In time to come the corporations can make use of this faith to draw from investors further money with which to build extensions, improve their road-beds and equipment, and, in general, return to their former activity. While such operating savings at first sight appear to be against the interests of the employés of the railroad and of those from whom it purchases its necessary supplies, yet to those who will look beyond the immediate future it will be seen that in no other way could the business problem of the railways be arranged. The passing cloud, therefore, has a silver lining.

These railway economies differ on different roads. Some are clearly legitimate—perhaps a majority of them. One company is sending out its trains with one brakeman short of the usual number. The remaining brakemen are told that if this plan for reducing the operation expenses should fail the wages of all will be reduced to a corresponding amount. The brakemen in service appreciate the situation, and, so far, by the exercise of special diligence, have prevented any disaster to the trains from lack of help. Of course, the air-brakes help the road greatly in its experiment. Other companies arranged for a year or more before the World's Fair to put their house in order for that event. Road-beds, cars, and engines were, during the year, brought up to an unusual degree efficiency. Now that the Fair is over, the expenditures of the last two years have been sufficient to leave the property in such condition that many of the ordinary repairs can, for the time, be omitted without reducing the plant below the normal standard. In this sense it is true, as stated by many companies, that, in spite of the decline in operating expenses, the property has been kept in good condition.

Certain classes of repairs have, however, only been postponed. A road which, owing to the dull traffic, has use for but three-quarters of its equipment, and which allows the other one-quarter to stand idle on the side-tracks, is always tempted to throw on to the siding a car which has been crippled, and to draw a good car for the daily service. In this way it may come about that the idle cars standing on the side-tracks will every one need repairs before they can again be put in use.

When the railroad managers see signs of a revival in general business they will be obliged to spend money freely—if they can get it—to repair the cars then needed, or else to see rival roads with better credit carry away the competitive tonnage. It is something of this sort which President Perkins, of the Chicago, Burlington and Quincy railroad, refers to in his annual report for 1893, when he speaks of "temporary economies, postponing where it could be done without impairing the safety and efficiency of the service, the expenditures which should properly have been made." The same matter was referred to by President Chauncey M. Depew, of the New York Central railroad, in the speech before the Trunk-Line Association when he said: "We cannot long maintain present economies. If we add lower rates the drain upon our roads will cost us an enormous amount, either in additional expenses or in issuing bonds to put us a year hence back where we are now." But in any case, the saving of expenses both legitimate and illegitimate is laying the foundation for a better credit in the future when the railways shall feel in effect the better times which the market is now enjoying in anticipation.

IT is well to turn for a moment from our own home affairs to glance at the position of railways which are radically different from our own. The director-general of railways for India has made a report for the fiscal year ending March 31, 1893, which has been printed by the British government. India, like Russia, being a debtor country, must pay its debts abroad in exports, and for this purpose the governments of both Russia and India find it advisable to encourage, and even to force, the sale of wheat abroad. In India the average yield to the acre is about nine bushels, which is often carried forty or more miles to the railway-station. From there to the port of export the haul on wheat is from 800 to 1000 miles, at the average rate of five mills per ton per mile, almost exactly the charge and the distance of our own trunk-lines from Chicago to the Atlantic seaboard. Wheat which is within 300 miles of the port is charged three times this price per ton. While the railways in India carry wheat at about the same tariffs quoted by American railways, their other charges are very high, ranging in the highest class from 4 to 7 cents per ton per mile,—nearly five times the charge of the American roads on dry-goods from the Atlantic seaboard to the Mississippi river.

But it is in the passenger service that the greatest differences appear. In the United States the freight revenues greatly exceed those from passengers, but in India the reverse is the case. Moreover, fares in India must be proportioned to the low standard of wages prevailing in that country, so we find that for third- and fourth-class passengers (natives) the fare is but ¼ cent per mile, or say from $2.50 to $5 for a trip from New York to Chicago. By far the greater part of this cheap travel is for short distances, and the low price of two cents per ticket is charged between stations not far apart. The railways recoup themselves for these low fares by running slow trains at infrequent intervals (but one a day in some cases) and crowding them to the utmost; thus the average number of passengers per train in India is over 200, and on one road the average is 274. We can realize how crowded the trains must be when we compare these averages with the United States average of 42 passengers per train-mile. Thus in India, in spite of the low fares charged to the natives the earnings per train-mile are about $1.05,—nearly the same as in the United States. The working of the Indian railways requires over three times as many employés per mile as in the United States, 96 per cent. of whom are natives, who have been slowly replacing Europeans in the minor positions of trust, snch as station agents, engine-drivers, and the like. The coal problem is serious in India so that the government has made unusual efforts to develop the fields existing. One or two of the companies import their supply from Cardiff, Wales, at a cost of from $4 to $7 per ton. These figures and costs in United States money are all based on the official value of the rupee in the fiscal year, given in the report as 1 shilling 4 pence,—or

about 33 cents. At present silver quotations a rupee is worth 8 or 10 cents less than that figure, so that the tariff charges at the present time are in fact lower than the range of rates already given. This fall in the silver value of the rupee causes a heavy deficit on those Indian railways which are worked by the state or under state guarantee. Capital for the Indian railways has been furnished from England, and the fixed charges are payable in gold. The fall of exchange in 1893 cost the government more than $3,000,000 for its railway guarantees, exclusive of sinking-funds. The average earnings per train-mile on the Indian railways are given as $1.40, the working expenses (47 per cent.) at 64 cents, and the net earnings 76 cents. These results, in spite of the great difference in details, are somewhat similar to the results on American railways, and furnish a curious proof of the fact that capital employed through large corporations will endeavor under any difficulties, to get its usual profit.

THE agricultural department at Washington has sent to the different railways a circular letter advocating the giving of more attention by the railways of the United States to common roads. That better wagon-roads are worth all they cost is generally admitted by those who study the subject, though it is not easy in all cases to tell the saving in dollars and cents. So much depends upon the peculiar circumstances of each farmer that no average estimate of the value of a good road can be made. If a farm is so poor or so inefficiently worked that the farmer can postpone the drayage of his products to the railway-station from a muddy day to a dry one, of course he is not so much concerned in having good wheeling in rainy weather; but then, neither is he a good business man.

The converse of the proposition is equally true. The railway company which transports the ambitious farmer's produce to market is interested with him in having wagon-roads good enough to admit of the cheapest drawing of that produce from the farm to the railway-station. It is estimated that grain, hauled an average distance of five miles to the railway-station, costs the farmer an average of $1 per ton; and while the saving under this amount by having good roads and by the use of broad tires will differ in different cases, yet anything which will reduce the cost of producing grain, or rather, give the farmer more profit, is a benefit to him and an indirect benefit to the carrying companies which depend upon the farmers' prosperity for their own. Good roads have also the indirect effect of increasing the productiveness of a railway company's tributary territory. The reason here briefly given in favor of better wagon-roads is sufficiently sound to warrant the railways in paying more attention to this subject. Indeed, they might with propriety take an active interest in the movement for good roads which is now slowly spreading throughout the country, and, when times are better, could afford to devote a part of their net earnings toward sharing with the farmers the expense of improving the common roads leading to the stations.

The common roads of Europe, as in Switzerland and Norway, are the principal highways of national communication. Railroads take their place, to a great extent, in the United States, so that the argument for good roads with us rests upon their value as feeders to the railways rather than upon their necessity as means of interstate communication. The cost of good roads may be set down as from $2500 to $5000 per mile, and if we estimate that farming land a mile back from the turnpike will be favorably affected, the cost of the new road per acre would be, say $2.50, and the requirements for maintainance of the road per acre about 25 cents annually. It is too early yet to say just how these sums should be divided among those benefited, but it is clear enough that the railroads might well become active in promoting the movement, and for their own advantage might contribute their share toward the expenses.

THE lately-threatened dissolution of the Southern Railway and Steamship Association has called attention anew to the importance of these associations. The Louis-

ville and Nashville company found its percentage of certain traffic slowly declining; thus its proportion of pig-iron and manufactured iron from the Birmingham, (Ala.) district for the six months ending December, 1892, was 53 per cent. while for the corresponding period of 1893 it was but 45 per cent. The president of the company charged this loss to the rate-cutting of competitors, and straightway gave notice of withdrawal from the association, a notice which, if carried out, would have meant a rate-war throughout the South and for all southern lines. Without expressing an opinion upon the merits of the case as presented by President M. H. Smith, of the Louisville and Nashville railroad, it is proper to say that it was a grave error of judgment to give notice of withdrawal from the association without first using the machinery of the association in an attempt to cure the evil complained of. Under the stringent provisions of the interstate law, railway associations now find it one of their high duties to act as arbitrators in disputes between members, to smooth over difficulties, and to remove those misunderstandings which may have no foundation in fact, but which are as fruitful a source of cut-rates as though they rested on good grounds.

After a session of a week or more in New York city, during which a full discussion of the grievances was had, the Louisville and Nashville Railroad Co. cancelled its notice of withdrawal, upon the agreement of the other lines to look carefully into its complaints. This action of the complaining company was right and proper. Associations have no reason for existence if they cannot be made use of by the members in case of an emergency. Traffics are poor on our railroads now, and if to this is to be added a war of rates—which under arbitration could be prevented—then it is time that the owners of railway stocks and bonds should exert their influences to save so much of the revenues of the companies as the hard times have left for them.

THE bill introduced into congress to change the clause making violations of the interstate law a misdemeanor for which railway officers could be sent to states prison, and to make such violations punishable only by a fine to be collected from the corporation, is a bill whose passage will go far toward remedying one of the weak spots in the act to regulate commerce. No subordinate railway officer will give a lower rate to one merchant than to another except by direct orders of his superior, or at least through a tacit understanding with him. The real responsibility for the action of each company on rate questions must rest upon the president and board of directors. It is worse than useless—it is unjust—to attempt to punish subordinates under these circumstances. Furthermore, no railway man, when put into the witness-box, will give evidence against a brother railway officer, though the latter may be employed by another company, because he knows that the offense is not justly chargeable to that subordinate alone. In the light of Judge Grosscup's decision, which seems good law and good sense, no railway man need testify about any transaction to which he is a party, because his testimony could certainly directly or indirectly be used against himself. On the other hand, the feeling of railroad men for each other does not extend to the competing road. If that competing road has been giving secret rebates, the officer of its rival will generally be willing to put his evidence before a court of justice, provided it is the corporation and not the subordinate officer which shall suffer the punishment. Thus, from all points of view, it would be much better to have the punishment for violations of the interstate commerce law visited upon the companies and not upon individuals; and this is what the bill now before congress proposes shall be done.

THE report of the railway commission of Massachusetts for 1893 contains as usual many interesting tables and much valuable discussion. One fact referred to in their report may be mentioned here. In two years the crossings of steam railroads in Massachusetts by electric street-railways have increased in number from 26 to 100. The board remarks that such crossings

should be permitted, if at all, only under careful regulations, similar to those which experience has proved to be necessary in regard to the crossing of railroads on the same level. "Of all the perils which attend travel on railways there is no one which, in the apprehension of the board, is so serious, both in its character and extent, as that here pointed out." The same subject is referred to in the annual report of the railway commissioners of Connecticut, while the danger of such crossings is made the occasion for remarks by President Roberts of the Pennsylvania railroad in the annual statement of that company. The railway community, at least, is awake to the great perils which would come from the threatened increase of crossings at grade of steam and electric roads.

THE petition for the removal of Receiver Oakes, of the Northern Pacific railroad, alleges that that gentleman, when president, promoted, or allowed to be promoted, many industries along the line of that railroad, out of which the directors and officers of the company made handsome profits. Without discussing at this time the merits of this particular case, it is well to state in few words a phase of the general subject which has not received much attention. The Northern and Union Pacific railways were chartered by special acts of congress thirty years ago. These charters provided for a single piece of road from one specific point to another, and nothing else. Our modern charters give railways the power of building additional lines and doing such other acts as are necessary for the development and operation of the road as a business. In the cases of the two roads named these powers are present in the charters only by implication. Even the legality of the guarantees upon branch-line bonds made by these two companies depends upon this implication, which has to be read between the lines, as it were. Ever since they were built, the managers of these two roads have been dependent for success upon increases in their traffic, brought about to a large extent through their own exertions. Everything was new and uncertain. The officers were required not only to manage the railroad proper, but to encourage the opening of new industries along the line. In short, by their positions they were compelled to be promoters of the general industrial prosperity of the states served. While this development of the country pressed upon them on the one hand, they were debarred by their charter from doing any of these things through the company itself. Anything, however necessary or however conducive to the interests of traffic, must either be left to the slow working of commercial forces or be engineered by the directors and officers of the company who know the circumstances and the needs better than any one else. These gentlemen were in a number of cases compelled thus to put their money into branch-roads, elevators, or mines before the ordinary Wall-street banking-house would think of investing. No railroad man has a right to speculate in the stock of his company for the decline, since such speculation would create a business interest adverse to that of the corporation; nor should he lend his aid in unloading upon the company worthless properties at exorbitant prices. But, on the other hand, it not only might not be wrong for him to invest his money in industries along the lines of his road, but it might be in the highest degree unselfish for him to do so; for the railway company might be benefited a hundred dollars where his profit would be but ten. In such cases his interest is not adverse to, but in accord with, that of the railway. In short, it is not just to say that investments should not be made by directors and officers along the line of their road, particularly in a new and developing country. Every such investment before the bar of public opinion must depend upon its own merits. The great increases in the traffic of the Northern and Union Pacific railroads, until last year, were owing to the business developed in part by the efforts of those interested in the property; while their failure to meet their interest charges for the year 1893 was due to other causes, not connected with this question of the development of contributing industries.

THE question of uniformity in railway bills of lading seems, like the poor, to be always with us. The boards of trade of the different commercial cities have been pressing a movement against the railways because of the forms of bills of lading which they, through their associations, recently adopted. This form made the railways, as common carriers, practically responsible to the shippers of freight for none of the losses and damages arising from transportation. Such a contract, it is well settled now, is not binding in law. With the one exception of a decision by the court of appeals of the state of New York, which seemed at the time to look in an opposite direction, the state courts have always held that a common carrier cannot make a contract which shall exempt himself from losses caused by his own negligence. This decision has also on the ground of public policy received the approval of the supreme court of the United States and may be now considered a part of our system of law. This being the case, no bill of lading could save the railroad from payment for losses for which it is and ought to be responsible. Why, then, should the illegal form of bill of lading be insisted on by the companies? The object seems to be two-fold: first, to escape the payment of claims presented by small shippers who are ignorant of the law, and who may be frightened off by the language of their bill of lading; second, to keep up the appearance of non-responsibility with the hopes that what the companies have always contended for they may in part eventually obtain. An observer, however, must see that this latter hope is a faint one; and as for the former reasoning, that certain shippers may fail to collect claims for honest losses, the position of the railways must be condemned by all right thinking people. Legislatures are often hard upon railways, but the common law is not, and with the safeguards granted by the method of releasing shipments and by the practise of carrying goods at owners' risk, the railways would fare as well as any of their customers by trusting themselves wholly to their common-law rights.

Exempting the carrier from certain specific losses arranged for by the signing of a release is a custom which yields to the railroads only what rightfully belongs to them. The carrier should be responsible for the losses arising from its own particular business of transportation such as damages from collisions, but it should not be held liable for losses which come about through the nature of the goods themselves; such, for example, as the fermenting of molasses or the damage which a horse, for illustration, may do himself in a car, or the losses which occur through the shaking of the goods, a thing which is inseparable from the mode of transport. It is also proper that lower rates should be given on articles shipped at owner's risk, covering for example, rust on manufactured iron arising from exposure to rain; provided, again, that the company has not been negligent.

As showing the value of the railway interests to the English manufacturers, and as exhibiting also the depression which is now prevailing to a greater or less degree throughout the world, the following table, copied from an English paper, gives the values of the locomotives exported from Great Britain to the countries named for three years:

	1891.	1892.	1893.
Russia	£ 1,374	£11,552	£13,746
Germany	14,985	8,888	3,403
Belgium	1,968	7,474	1,151
France	8,674	8,556	10,047
Spain and Canaries	105,581	49,527	21,421
Other countries in Europe	156,642	172,150	48,722
United States	13,253	2,382	16,336
South America	455,893	182,623	139,726
British Africa	78,995	97,171	81,034
British East India	336,061	159,983	346,073
Australasia	308,385	216,082	85,762
Other countries	135,744	66,764	84,638
Totals	£1,617,254	£983,752	£852,059

Except for the increase in 1893 over 1892 in the engines shipped to British East India, the decrease would have been much more marked. The increase shown in shipments to the United States is doubtless to be accounted for by the exhibits for the World's Fair.

ARCHITECTURE

Conducted by Barr Ferree.

THE difficulties of conducting architectural criticism in the columns of a real-estate journal have seldom been more amusingly illustrated than in some recent issues of the New York *Record and Guide*. As a real-estate journal this weekly paper is quite without a peer in America, and has won itself a name of enviable excellence in its own special field. It seeks to illumine the dull statistical tone of real-estate essays by printing, from time to time, comments on architecture, that being an allied topic. It is sometimes wickedly suggested, in semi-literary circles in New York, that the dramatic criticisms of one of the greatest of the metropolitan dailies are composed by an ancient Apple Woman, who passes her days behind a stand closely adjacent to the offices of that organ of culture and light. We presume that the *Record and Guide's* recent criticism on the new Metropolitan Club house in New York was composed by the thrifty Italian who sells sweets and other alleged delights close by the door of that journal. Such remarks as "the Dago murders repose" and a reference to Italian journeymen recall Mulberry Bend rather than the sober remarks of a sober critic. And that gentleman—if it be a gentleman—finds the building "as nearly devoid of architecture as a factory. It shows no composition except in the proportioning of the stories to each other, no features, and no detail except that of the balconies and the cornice." Verily, what should have been given us? Should there have been variety for variety's sake? A breaking of lines, a mixing of masses, an elaboration of ornament simply to please the Dagoish mind of the real-estate critic, who, by the way, would rather the building were of brown stone than of white marble? The trouble with this critic is that he was not consulted in the beginning. Architects would save themselves many sleepless nights and painful hours if they would remember always to consult the critic beforehand. He invariably knows so much better what to do than any one else that it should be a pleasure for the jaded architect to seek inspiration at his hands, instead of awaiting condemnation after everything has been completed. But this is neither here nor there. The Metropolitan Club house is doubtless fully satisfactory to those who made it and who use it, and who else need be consulted? It is very far from being a faultless building, but it certainly does not deserve the thoughtless remarks to which we are directing attention. Were we to classify them we should certainly call them Paleozoic criticisms, for no modern man in touch with live ideas could have written them. Now mark the tribulations of the real-estate critic. The very week after condemning one of the most beautiful and scholarly buildings in New York the worthy paper saw fit to spread itself on the "beauties" of the Dekker building, distinctly one of the most distressful edifices in America. "Its bright, lofty, ornate façade enjoys from the square what is possible with but few of the modern high office-buildings—a good perspective," it writes. "This was doubtless an inspiration to the architect . . . . The offices are finished in style to harmonize with the highly artistic exterior." Thus is art encouraged by the leading real-estate organ in America. We should be inclined to say that it was paid for the last remarks, and paid some one for making the former ones, were it not for the reference to internal and external harmony. This was one of the strong points of the critic on the Metropolitan Club, only that there they did not harmonize, while in the Dekker building he gives us his word that they do. The fine mind of the Italian dispenser of

sweets is observable in both productions. We shall enshrine both these effusions in our collection of curiosities of criticism, and herewith place them in an exalted nook.

MR. THOMAS HASTINGS has been delivering some lectures on architecture at Harvard University, where he has made a profound impression by the earnestness of his discourse and by the charm of his enthusiasm. This is quite as it should be, and the students at Cambridge and the good people of Boston generally are to be congratulated on having secured the instruction of one of the most capable and distinguished architects of the day. Mr. Hastings's work is not always of that evenness that is to be expected from so thorough an artist and so accomplished an architect, but he has already—with many years of progress and study before him, God grant—accomplished a vast deal of delightful work that has given ample evidence of a rare artistic feeling. His utterances on architectural questions are therefore entitled to the widest hearing, and this we have no doubt will follow from his recent discourses at Harvard. Mr. Hastings represents, however, but one side of the current architectural thought of the day. He has so steeped himself in the Renaissance that he can represent only that one form of architecture, albeit one of the most interesting and varied. And he is not to be thought the less of on that account; for he has not only the courage of his convictions, but—a rare thing among American architects—the ability to defend them with unusual vigor and skill. However we may differ with him in the question of style, we can at least admire him for this quality and recognize the earnestness and thoroughness of his work. At the same time it would be well for the Harvard authorities to bear in mind that he has shown them only one aspect of current architecture. Having now taught the Renaissance by means of one of its most brilliant practitioners, it behooves them to cast around for some one to tell them the other side. And they will have to look far to obtain so satisfying a representation as Mr. Hastings has given them of his school.

THE collapse of the effort of the American Institute of Architects to induce the secretary of the treasury to put into practical operation the law authorizing competitions for government buildings is quite the most serious blow that venerable society has met with in its long existence. The correspondence in the matter has been made public and all those interested in the case are doubtless entirely familiar with its details. The unexpected ending to so many years of labor—for the efforts of the Institute towards this end have been its most important occupation since its organization—must be a matter of regret to all parties. It is quite natural that the president of the Institute should feel aggrieved over the results of his labors, but dispassionate reading of the correspondence clearly shows that if it was not conducted throughout on the most courteous lines, the discourtesy was not one sided. To begin at the beginning, the directors of the Institute acted with somewhat unnecessary haste in condemning the plan for the Buffalo building, out of which the whole controversy has arisen, on the strength of a newspaper cut. No architects ever before undertook to pass judgment by architectural illustrations in the daily press, and the decided criticisms made on this most undecisive evidence doubtless created ill-feeling in the offices of the secretary of the treasury and in that of the supervising architect, which very probaby influenced the whole tenor of the later correspondence. The supervising architect, on his part, need not, perhaps, have written just the letter he did in reply to this communication, which appears to have been properly enough referred to him. But he was clearly within his rights when he wrote it, which his opponent as certainly was not in demanding its withdrawal before anything else could be considered. All of these things are small matters, but on both sides a tendency towards dogmatism early developed that culminated in acrimony towards the conclusion. Business men, so far as our knowledge goes, do not tell each other their respective communications are insulting, if future business relations are anticipated. Neither

do men asking a favor, or for the adoption of a plan devised especially in their interest, assume a defiant tone. The secretary of the treasury was clearly within his lawful rights in refusing to follow the suggestions of the American Institute of Architects. Architects are prone to anger towards those who do not agree with them, and the present case has proved no exception to the rule. The chief crime of the secretary has been, not so much his refusal to cancel work already accomplished on the building for Buffalo, but in presuming to pass judgment on an alleged point of architectural interest that did not agree with the advice tendered him by the Institute. But the whole thing is terribly regrettable. The Institute is now further back in public estimation than it ever was. The treasury department has definitely announced that it will not act on the permissive legislation passed by the last congress. And that is where the matter stands. The case is very much like that of the inventor: he has a fine idea for the other man if he can only convince him of it. The Institute had an idea and wanted it put into effect, but was unable to convince the necessary official of the value and efficiency of its proposals. It is to be hoped that the Institute will not waste valuable breath in berating the honorable the secretary of the treasury. Rather let it devote itself to strengthening its views and arguments, so that when next a favorable opening occurs to help on the reformation of government architecture in America, its position will be absolutely impregnable. And when this time comes, as it may, we would suggest that the correspondence of the Institute be couched in terms which recognize the right of the treasury department to exercise its own discretion in the matter, unless, perhaps, a new law shall have been put into effect. The present correspondence was conducted wholly by the president of the Institute, not by its secretary.

JOSEPH'S historic coat of many colors would have seemed a very sad-colored garment indeed had it been placed in the rooms in which the department of architecture of the Brooklyn Institute of Arts and Sciences held its recent third annual exhibition. The walls literally blazed with color, and so brilliant was the effect that it seemed almost impossible not to think some fresh tints had been invented for the occasion. In a collection of this sort, confessedly for the benefit of the unenlightened "public," and conducted with so much regard to color, few really architectural drawings were to be looked for. The most notable of these was a line drawing from Messrs. McKim, Mead & White, of Bates Hall, in their Boston Library building. The value of this splendid piece of work was somewhat offset by the picture of their new Brooklyn Museum, with the extraordinary sky, which was shown for the first time in the last League exhibition. If our memory serves us aright there were but three plans in the whole exhibition, but an abundance of Turkish and Persian rugs, some good pieces of old furniture, Japanese umbrellas, vases, pedestals of costly marble, pictures, cartoons, decorative schemes, real and alleged; everything, in fact, needful for an architectural exhibition, as such things are now conducted, but architectural drawings. The number and variety of the water-colors scarcely compensated for the lack of real things for the architect, but they served to point the present absurd tendency towards color in all sorts of drawings for all sorts of purposes. But if the Brooklyn exhibition was lacking in architectural drawings, it certainly achieved the distinction of being the most brilliant collection of the kind brought together up to date. It is always something to have done what was never done before, even if it is not the best thing imaginable, and a certain distinction is given to any one who achieves the utmost in any one direction. From this standpoint, therefore, the Brooklyn exhibition must be pronounced an extraordinary success. It is to be hoped that, in time, the real meaning and nature of an architectural exhibition will be comprehended in that city; meanwhile she is to be congratulated on having done the best that she could, and having done it well according to her lights.

No city on the globe is more in need of an architectural school than the good city of Philadelphia. That ancient and quiet town boasts the possession of more architectural wonders than may be found elsewhere on the same area, and it is quite in the proper order of things that an architectural school should flourish in their midst. Yet, strange as it may appear, the School of Architecture of the University of Pennsylvania, which is rapidly becoming the center of architectural interest of what is now called by many optimistic persons "New Philadelphia," has been founded with the idea of showing Philadelphians the real abominations of their own handiwork. In other words, there is growing up in Philadelphia a real and important School of Architecture that bids fair, in a very short time, to equal in importance any of the older schools in the country. Never was there greater need for such an institution; never was a broader field opened to a body of reformers. The School of Architecture of the University of Pennsylvania has several peculiarities of its own. In the first place, it is located in Philadelphia, a highly-significant fact, and one quite sufficient to give it unique rank among similar institutions. In the second place its faculty includes a number of practising architects, of whom the names of Messrs. Frank Miles Day and Wilson Eyre are alone sufficient to guarantee the progressive qualities of the School and give it an importance entirely its own. The greatest danger of professional schools, not architectural alone, but of all sorts, is fossilization. The professor, busily engaged in teaching the elements of his profession, is apt to forget the real progress he can learn only by keeping constantly and closely in touch with it. The Philadelphia School, it will be noted, entirely removes the possibility of stagnation by associating active architects of the first rank in its management and teaching. And lastly, this School is extremely fortunate to have at its head Professor Warren P. Laird, who combines executive skill with artistic enthusiasm in an unusual degree. Placed at the head of an important school early in life this gentleman has shown himself entirely worthy of the confidence placed in him. Whatever the School of Architecture of the University of Pennsylvania is to-day is due entirely to the labors of Professor Laird; and fifty years hence the mark of his work will still be felt. The future of this School must be a matter of the first interest to all interested in architectural education in America. Though conducted on the usual French-American plan that appears indispensable in American schools of architecture, it gives evidence of a modern feeling that is suggestive of better things to come. We are glad to congratulate Professor Laird on the good work he is doing, and the people of Philadelphia on having the benefits of his services. The School of Architecture of the University of Pennsylvania is the only architectural school we know of in which 20 per cent. of its faculty is composed of Doctors of Medicine.

"A YOUNG ARCHITECT" calls our attention to the fact that, in cataloguing the methods of obtaining success in architecture, as we did recently, we neglected to omit what, we presume, may be called the genealogical or connective method. We acknowledge the omission, and hasten to correct it. This method is quite obvious, depending, as its name implies, upon the rich and influential connections a young man may have and from whom work may be obtained. It is a most important element in success, and, if the young architect is abundantly supplied with such desirable relatives and connections, he has only to inspire them with a sufficient respect for his abilities to obtain the very greatest of successes, without the smallest aid from a public voice or the slightest necessity for performing on his own trumpet. Every one will agree with this, and it helps to point the lesson we sought to bring out in our previous remarks on the subject, that architectural success is quite apart from architectural merit and that one may be the most utterly bad architect in the world and yet secure the greatest proportion of "jobs." Alas! that the refined soul of the artist-

architect should stoop to the necessity of looking up "jobs." Alas! that the long-suffering public must stand for all time—for the bad work invariably lasts unconscionably—the results of such a system. Alas! for those inspired minds that can do good things—on paper—and never get an opportunity to show the world how much better they would look were they carried out as they conceived them than most of what is done. Alas! for the time that permits such things. Alas! for the lack of knowledge and appreciation that makes it an element in our current work. Alas! that opportunities for the workings of architectural geniuses should depend on such sordid conditions Alas! that so much good work is lost, and, alas! that so much that is bad is carried out. Alas! that the puller-in (of jobs) should go on his way rejoicing through life and the good man should die unknown and unappreciated. Alas! this is a veritable wilderness of architectural woe, and the time we live in, yes (alas!), almost our own country, is the most woeful vale of any time, of any land, of any race. Alas! oh alas! for a voice with which to wail over the dull, dreary, disconsolate, distorted conditions of our architecture. Alas! alas! alas!

A COMMITTEE of the Architectural League has drawn up a series of rules for the government of architectural exhibitions that must strike terror to the hearts of those slipshod architects who try to erect buildings without suitable drawings, or at least with the aid of drawings that are not showable. The number of these gentlemen is increasing with lamentable rapidity, and both architectural publishers and exhibition committees are loud in their complaints of the difficulties of obtaining suitable drawings. If the rules proposed by the League's committee are carried out this difficulty will be remedied in the most thorough manner. Briefly, these rules require that all perspectives must be accompanied with plans; that a large-scale drawing or detail of some one portion of the building shall accompany each exhibit; that the object of the exhibition shall be to exhibit a complete representation of each building rather than a greater number incomplete in essential details. With these suggestions go the further recommendation that sufficient notice be given prior to the holding of an exhibition of architectural drawing to enable proper preparation to be made for it. With the exception of very young men whose genius has not yet received the recognition it deserves, it is doubtful if any practising architect has the time necessary to make the desired preparations for exhibitions contained in these suggestions. That they are good in themselves goes without saying; that they are directly in the line of progress and of art is likewise incontrovertible; that architectural exhibitions would be raised to a sorely needed standard were they carried into effect is unquestionable; but with all this it may be asked if the standard set is not too high to meet actual conditions; if more is not asked for than individual architects may be disposed to give for the benefit of their professional brothers; if it is not the ideal that is set forth rather than the practical. It would scarcely seem advisable to set up an ideal standard in this busy practical unideal world that will not take into account its unideality and horrible practicability. The architectural standards of architectural exhibitions sadly need elevation and improvement, but it is doubtful if this happy end will be brought about by insisting on conditions that will close these collections to the larger body of architects. The suggestions of the committee are, however, entitled to the most exhaustive consideration, and are very decided evidence of the earnestness with which some architects view their professional responsibility.

THE insistance on the plan as secondary to the elevation, which is one of the cardinal principles of the École men, is a position in architecture that we must confess we do not understand. The importance of the plan is a matter on which there can be no dispute. But a good plan is very far from implying a good exterior; nor does a good exterior imply a good plan. That it should need not be argued; all we are concerned with is that it does not. The

plan is the part of the structure we live in; it is the thing that determines the value of the building and is itself determined by its function. But no thoughtful architect should rest satisfied with a plan, be it ever so fine. The most perfect and splendid plan in the world is utterly useless in itself until the walls have been built and roofs put on. Indeed, if we look at the question from this standpoint, the plan becomes somewhat insignificant, since it is possible to live within walls and under roofs with the most unartistic plan in the world. The vertical elements of the building cannot, therefore, be referred to unimportant places in the whole conception, and any system that ignores the elevation in order to put more thought upon the plan is deliberately ignoring a fundamental part of architecture. Students at the École des Beaux-Arts think it no unusual thing to devote almost all their time, in working up a problem, to the plan, leaving the elevation to the last few days, a system that thoroughly accounts for the inferior nature of many École elevations. It is not a misfortune that the elevation is simply the part of the building we see, while the plan is the part we live in. It should be as much the duty of the architect to line the streets of our cities with structures pleasing to look upon, satisfying, artistic, perhaps beautiful, as that he should arrange their interiors to present a monumental aspect when possible, to show good domestic arrangements, when the structure is of that class, to arrange for rapid and ready mode of ingress and egress when these are the most important elements to be taken into account. No one will contend that the elevation should be slighted, but when it is placed secondary to the plan it is sometimes very easy to do so. Let us have good plans, if we can—artistic ones if possible—but let us have fine and satisfying exteriors with them.

THE working library of the modern architect includes a variety of industrial publications, which business competition and the desire to please have long since made costly books. Perhaps no series of the industrial catalogues the architect is called upon to consult are now more costly than those issued by hardware firms. Covering all branches of the trade, they still include a vast amount of information useful to the architect, who cannot well afford to be without representative publications of this class. Among the more important of these catalogues that have recently come to us special mention may be made of that issued by the Lee-Clarke-Andreesen Hardware Co., of Omaha. It is a ponderous quarto of 1012 pages, abundantly and handsomely illustrated, and covering the entire range of the hardware industry. The subjects are arranged under heads and the architect and builder will lose no time in finding their specialties.——The catalogue of the W. Bingham Co., of Cleveland, is a valuable and interesting book of 1476 pages, illustrated with nearly 7000 engravings The page is a small octavo, and for convenience in handling it has manifest superiority over the older style of quarto catalogues. The list of subjects catalogued is wide, the arrangement good, and the whole work a model of its kind.——P. & F. Corbin, of New Britain and New York, send us a portfolio of "fine builders' hardware." It is printed in good style and purports to illustrate the more expensive grade of door-hinges, knobs, and the like. Some of these, however, are of an aggressive and obtrusive design that cannot be commended for good taste. We imagine, however, that they fill a well-tested demand, and therefore enjoy a popularity of their own.——The Ludlow-Saylor Wire Co., of St. Louis, send us a large illustrated catalogue of the metal-work made by them,—chiefly railings, elevator-enclosures, gateways, iron fencing, and the like. Many of the designs are very striking and good, and a large number are of sufficient grace and beauty, without over-elaboration, to render them very acceptable.——The Heckla Iron Works, of New York, send us a couple of illustrated catalogues, representing their work in a very thorough and convenient manner.

MINING AND METALLURGY

Conducted by Albert Williams, Jr.

ALMOST important ruling, which will directly affect many mining titles, has been rendered by the United States supreme court in the Amy-Silversmith case. In this instance the course of the vein had carried it, not through the end lines, as presumed by the locator, but across the side lines, and the owner in following the deposit down on the dip had worked beyond the vertical plane of a side line into adjoining property. Suit was brought to recover value of ore extracted from the disputed ground and the case was finally carried up to the supreme court. In similar cases, which have been numerous, the lower courts have usually held that the end line should be drawn back to the point where the apex crosses a side line, and the mooted point has been, not whether the locator was entitled to take ore from beyond his side line, in following the vein down, but to what extent, the discrepancies in the rulings having been as to whether the amended end lines should be drawn at right angles to the strike or at right angles to the side lines. As is generally known, the United States mining-law permits working beyond the vertical projection of the side lines and prohibits working beyond the vertical planes of the end lines; also that the side lines must be parallel to each other in every part, though not necessarily straight, and that the end lines must be parallel to each other. This latest decision, which overrules all former ones and will be the established precedent for the future, holds that what were called side lines are in fact end lines; hence, that the owner cannot go beyond them. It also holds that it is not the duty of the court to relocate for an owner who has made a mistake in laying off his claim, and do for him what he should have done for himself; in short, that he must abide by his error, and that all that the court can do is to secure him in the possession of that ground to which he is entitled on the narrowest construction. The ruling is very clear and positive. It will no doubt work hardship in many cases yet to be tried, but it is the final say of the court of last appeal and must stand. It will be well for prospectors and mine-owners to seriously realize this, and use great care in staking off claims. As a matter of fact, it is often difficult to trace an apex through the whole length (1500 feet) of a claim and to make sure that it is contained within the width (300 feet on each side, according to the United States law, and much less according to some district regulations) at the ends. At the time the stakes are set the small amount of development work does not always determine the true course of the vein, as there may not be continuous croppings and the blind parts may be covered by heavy wash. Locators will have to exercise great care and judgment in fixing their surface boundaries. It has been suggested that this ruling will also affect a class of locations in which the apex is contained within one end line but not within the other, crossing a side line instead. Such cases are not uncommon. Evidently the decision, while finally clearing up a perplexing point, opens the gates to a new tide of litigation, the result of our complicated laws, already so injurious and deplorable.

THE long-continued strike of the miners in the Cripple Creek (Colorado) gold-camp was for eight hours' work, instead of nine (previously the custom in that district), and to receive $3 a shift, the wages formerly paid for a nine-hour shift. Plenty of men were willing to accept the old terms or the proposed compromise of 33⅓ cents an hour, but when the companies tried to start up again on the former basis, intimidation was resorted to by the

strikers. The sheriff, being unable to protect the working miners and the companies' property, called upon the governor to order out the militia. The militia, after a brief demonstration, but accomplishing nothing, were retired by order of the governor. In this case, as in so many others, the strikers had a clearly hopeless chance from the start. The mine-owners could afford to close down and wait, but the men could not. As a question of policy, to say nothing of right or wrong, the strikers placed themselves in a false position by threats and actions. Nobody denies a man's right to refuse to work on terms that do not suit him; but the other man, who is willing to accept such terms, has an equal right to do so, and should be protected. The trouble at Cripple Creek involved a deeper issue than a small dispute about time and wages; it brought out anew the underlying principle of inherent rights, and the public, understanding the situation, has withheld sympathy from the strikers. There is no prejudice against miners' unions as such, so long as they keep within reasonable purposes and do not infringe upon common justice. They can do much good in their proper sphere, but too often do harm; and the injury almost always falls upon their members in the end. In this latest instance, as has so often happened, the agitation seems to have been stirred up by a few wrong-headed leaders, and was not the result of unanimous feeling; though the men, regarding it as a test of union strength, stood by their colors whatever their individual judgment may have been as to the merits of the struggle.

IN designing mining or metallurgical plant, the element which corresponds to the factor of safety (or, rather, of uncertainty) in civil and mechanical engineering is necessarily a large one, from the nature of the conditions, which are various and uncertain. An extra margin of strength is always advisable, and where the additional weight is a drawback in transportation from the foundry or machine-shop to the site of the works, it is customary to resort to sectional construction. Great ingenuity has been bestowed in producing composite machines and appliances, the object being to avoid sacrifice of stability while making the parts easily transportable. The limit of weight in single parts, for use in Spanish American countries and in the less accessible portions of the United States, is from 250 to 300 pounds, or the weight that can be "packed" by mule.

Similiar to this allowance for extra strength (whether provided in the usual forms of construction or in built-up machines) is the extra margin of power allowed, to insure regularity and reliability, which are more essential in mining and most metallurgical plant than in factories nearer the base of supplies and more readily remodeled. It is important that all allowances should be made at the right end; that is, at the beginning. Thus the boiler rating should not only be above the nominal engine-rating (which is sometimes only about half the indicated horse-power), but with a fair surplus above all expected demands, as it is often necessary to add small auxiliary motors, feed- and fire-pumps, etc., not counted in the first calculations and for which small separate boilers would be inconvenient. This rule applies to all powers, as well as to steam. In mining it is not always certain what maximum loads may have to be handled, so the engine in its turn should have a surplus power above normal requirements.

The same principle holds in many other directions. For example, it is always prudent to select sites and design foundations and housing with a certain excess, to allow for future enlargements, or, for a last example, though many more might be quoted, take the question of water supply for an amalgamation or concentration or combination mill. Turning to the catalogue of a leading machine-shop, we find, after the estimate of 7½ gallons per horse-power per hour, the following requirements stated: for each stamp, 72 gallons; for each pan, 120 gallons; for each settler, 60 gallons; for each belt vanner, about 90 gallons of fresh water per hour, and there are like proportions for other machines and apparatus. But it would not do to figure on a water-supply that would

only just come up to the total of these items, even allowing for pumping back and re-using (at a loss of 25 to 33⅓ per cent.) the water from settling ponds, for certain restricted uses. Each item should be considered as a minimum, and a very ample allowance must be made in the total supply to cover inevitable loss by leakage and evaporation, and to meet the many demands not specified. It is true that there are records of 10-stamp mills being run on 700 gallons per hour, but such figures must be accepted guardedly. The general principle is that a very liberal margin must be provided to start with, both in power and everything else, and the original plant, may then, as it were, taper down toward the last machine or use. It is easy enough to add on at the lower end.

THE latest estimate of the amount of royalties on coal- and metal-mining in Great Britain at hand is for 1889, when the figure was put at about £5,000,000. There are no statistics or estimates regarding similar royalties (paid, however, to owners of the land, not to the government) in the United States or for any considerable part of them. But the total amount must be very large, considering the great numbers of coal and iron mines, besides some others (as phosphate mines, for instance), that are operated on this plan. In the far west also there are the "leasing" and "tribute" systems of working mines of the precious metals and their accessories, and in the aggregate the amount thus paid by operators to owners must be considerable. A royalty (as the word itself indicates, in its original sense) in many or most foreign countries usually means the percentage paid to the crown, which under old laws never relinquishes the theory of inherent ownership to mineral lands.

THE Chicago exponent of the coal trade, *Black Diamond*, speaking of a newly-invented and much-lauded electric coal-mine lamp, after noting that the crowning merit of the lamp, according to the reports, is that "it has been repeatedly broken in gases much more explosive than fire-damp, without an explosion, very sensibly remarks that "it will be more satisfactory to test the fact in our [coal] mines and find out for ourselves the virtues of this lamp before believing in them." It is difficult to understand how the act of breaking can so instantly extinguish the lamp by any device for shutting off the current as to remove all danger. Even after the current has ceased the filament continues to glow for an appreciable time, and at a temperature sufficiently high for ignition. This has been the great obstacle in all electric light safety lamps, and it would seem a simpler, more rational plan to design them with a view to preventing breakage rather than to endeavor to make them safe in that event. Still, it is possible that the feat has been accomplished, like so many other unlooked for things, and thus it is premature to hazard an adverse criticism, though, with *Black Diamond*, we should like to see it done.

CRUSHING-ROLLS of an entirely new type have recently been introduced. Their novelty, as compared with the plain Cornish rolls and the many modifications from the latter, consists in the peculiar construction and arrangement of the crushing faces, which, instead of being plain cylindrical shells, have a series of deep parallel corrugations extending across the shells, either parallel or inclined to their axes. These corrugations are rounded or curved with such proportions that they intermesh, the idea being to cause every portion of the surface to press equally upon the counterpart of the opposite roller. The rolls are held in position by steel gear, slipping of the faces upon each other or the material to be crushed being claimed to be impossible. Rolls of this type should crush with little grinding, and by avoiding the making of slimes should give a satisfactory product for sampling, concentration, and lixiviation — which is one of the best features of all roller crushers. Without knowing how the new rolls stand long usage, it would seem that the disadvantages most likely to be expected would be the difficulty of keeping the faces true, additional danger of breakage

of gears in case of overstrain should an obstruction like a hammer-head or other tool drop in, and a more expensive shape to produce. But the principle evidently has its merits.

ANOTHER "new" patented process for rapidly chlorinating gold under pressure, and for rapid filtering of the pulp, has a familiar appearance in its published description. In the main it is said to consist in generating the chlorin in the chlorinating vessel, the gas making its own pressure. The special patent on the filtration seems to depend on the use of charcoal, by which the gold is reduced to the metallic state and is precipitated on and in the filter. Both ideas are sound, but are by no means novel, having been proposed, experimented upon, and used in practice years ago.

AN advance statement of the total mineral production of the United States in 1893, to be published in the forthcoming volume of the "Mineral Industry," gives the following figures, which, though still subject to revision, are claimed to be very nearly accurate:

Asbestos, short tons	120
Antimony ore, short tons	850
Asphaltum and asphalt rock, short tons	34,944
Barytes (crude), short tons	26,632
Bauxite, short tons	11,041
Borax, pounds	8,690,000
Bromine, pounds	348,399
Cement (hydraulic), barrels	7,503,385
Cement (Portland), barrels	596,531
Coal, anthracite, long tons	48,044,834
Coal, bituminous, long [?] tons	113,847,568
Coke, short tons	9,792,330
Cobalt oxid, pounds	3,893
Copperas, short tons	16,000
Corundum, short tons	1,747
Chrome ore, long tons	1,629
Feldspar, long tons	17,000
Flint, long tons	38,000
Fluorspar, short tons	9,700
Grindstones, short tons	45,580
Infusorial earth and tripoli, short tons	1,709
Limestone, for iron flux, long tons	4,551,000
Magnesite, short tons	1,143
Manganese ore, long tons	9,150
Marl, short tons	110,000
Mica, pounds	75,000
Onyx, cubic feet	2,175
Ozocerite (refined), pounds	none.
Petroleum, barrels	50,349,228
Phosphate rock, long tons	983,340
Plumbago (refined), pounds	896,603
Plumbago (crude), short tons	1,500
Pyrites, long tons	95,000
Salt, barrels	11,435,187
Slate (for roofing), squares	871,500
Soapstone, short tons	20,100
Soda (natural), short tons	2,500
Sulphur, short tons	1,344
Talc (fibrous), short tons	36,500
Venetian red, short tons	3,830
METALLIC PRODUCTS:	
Antimony, short tons	350
Copper, pounds	322,585,500
Gold, troy ounces	1,731,700
Pig-iron, long tons	7,043,384
Lead, short tons	193,928
Nickel, pounds	25,898
Quicksilver, flasks (76½ pounds)	30,161
Silver, troy ounces	60,500,000
Spiegeleisen and ferro-manganese, long tons	81,118
Tin, pounds	none.
Zinc, short tons	73,355

Most of the items show a decrease in production as compared with the output in 1892, the decline having mostly occurred in the latter half of 1893, after the midsummer financial crisis. Still the list makes an impressive showing.

THE notes in this Department on inclines versus vertical shafts have elicited considerable correspondence on the question. Among others, Mr. W. D. Brunton, general-manager of the Della S. Consolidated silver-mines and Cowenhoven tunnel at Aspen, writes that the solution of the problem in the case of that property has been extremely satisfactory. He gives the following account of the method pursued:

Two years ago the writer was brought face to face with the problem of shaft versus incline in a mine where the conditions were more than ordinarily complicated. Work had to be commenced upon an ore body pitching at an angle of 56° from the horizontal, which had been intersected by the Cowenhoven tunnel, nearly three-quarters of a mile from its mouth and 1000 feet vertically below the surface. It was out of

the question to drift through the ore body into the hanging wall so as to intersect the vein with a vertical shaft at any reasonable depth, as the shales which overlaid the ore had an unfortunate habit of "creeping" in and crushing timbers faster than any company could afford to renew them. Directly underneath the ore body, and separated from it by about 80 feet of dolomite, was an open porous stratum of silicious dolomite threaded with a network of water courses. If a vertical shaft were sunk from the point where the ore body was intersected by the tunnel, it would pass directly through this water-bearing stratum, which would also be intersected by every cross-cut from the shaft to the ore bodies on their continuation below.

Inclines, as every miner knows, are unhandy, expensive, and dangerous, and an existing 750-foot incline on the same property had proved itself such an unfailing source of worry to the manager and expense to the company that the prospect of a second incline was as much dreaded as a flooded shaft. One day, while I was studying the question, the following idea suggested itself. "If a shaft, after having been properly sunk and timbered, should be thrown out of the perpendicular by some movement of the earth's crust, would it cease to be shaft because it was no longer plumb, and if it was tilted over on its end instead of its side would there be any reason why the cars could not be run directly from the cages into the drifts without interfering in any way with the pump compartment or man-way?" Never was an idea more eagerly welcomed or acted upon with greater good will by all concerned. The miners who began work on the shaft, especially the old-timers, who are naturally conservative, looked with some suspicion upon this plan, but before a week had elapsed they arrived at the unanimous conclusion that an inclined shaft was easier to sink, safer to work in, and more convenient to operate than a vertical shaft, and that the old-fashioned incline should hereafter be considered a thing of the past.

This inclined shaft has now been sunk to a depth of 250 feet in the face of a very heavy flux of water, in extremely difficult ground, and so far without a single accident. At 84-foot intervals levels are run out from the shaft each way, down to which the tunnel cars are lowered on a cage, beneath which is attached a light steel self-dumping skip for the use of the men who are sinking, and the operation of drifting, mining and sinking go on simultaneously without in the least interfering with each other.

The incline spoken of is two-compartment and has its longer axis of cross section at right angles to the dip instead of parallel with it as more usual. The pump-compartment is above the hoisting compartment. It is locally called an "inclined shaft" rather than an "inclined winze" because, as Mr. Brunton explains, "ordinarily we speak of a winze as an underground connection between two levels, but the main opening from which these levels are driven should be designated as a shaft or incline no matter whether it terminates on the surface or at a station a thousand feet below." The hoisting machinery is situated in a large station cut out of the solid rock on the level of the Cowenhoven tunnel. There is no intention of connecting this incline shaft with the surface, as there could be no possible gain by such a proceeding. The machinery is at present operated by compressed air, but an entire electrical equipment, including hoist, pump-winch and pumps has already been ordered. The "cage" runs on wheels, but is altogether different from the Comstock giraffe.

ALUMINUM-BRONZE, nine parts copper to one of aluminum, has a very high tensile strength, and it is said that the alloy can be produced in castings for about the same cost as crucible steel. It has been suggested that its use might be extended to replace steel for many more purposes than is now done, as the castings can be made very true to pattern, thus saving part of the expense of working to shape. For certain uses, as in replacing ornamental ironwork, its golden color recommends it as improving the artistic effect.

IN most of the foreign countries and the states of the Union which have mining laws at all, it is required that each mine must have two exits, but the rule is very commonly evaded or ignored. A recent fire in a California gold-mine has sharply directed attention anew to the urgent necessity of providing means of escape to miners who may be shut off from the main shaft or other principal opening in case of fire or caving; and old

air-shafts are being repaired and made feasible for egress. The substitution of iron ladders, not subject to decay, in place of wooden ones has been recommended and adopted as a further precaution.

THE spelter (zinc) production of the United States in 1893, as compiled by Mr. Charles Kirchhoff, Jr., agent for the division of mining statistics of the geological survey, was: Eastern and southern states, 12,684 tons (2000 pounds); Illinois, 29,596 tons; Kansas, 22,815 tons; Missouri, 13,737 tons; total, 78,832 tons, against 87,160 tons in 1892. The decline in the output took place wholly in the second half of the year. The production of zinc oxid is estimated at 24,059 tons, of which 14,954 net tons was produced in the eastern district, as compared with 19,129 tons in 1892, and 9150 was made in the west in 1893, as compared with an estimate of 7700 tons in 1892.

VENTILATION by an electric-driven fan has recently been tested in a German colliery. The workings having been much extended, it was found necessary to sink an air shaft two miles distant from the old shafts. A Capell fan was then put in, with a double 10-foot inlet, operated direct by two slow-speed electric motors, one on each side of the fan, one being held in reserve. The results were as follows: electric horse power of dynamo, 47; electric horse-power on fan-motor two miles off, 43; indication of engine, 64 horse-power; revolutions of fan and motor per minute, 197; water gage, 2.4"; cubic feet of air per minute, 88,500; useful effect of fan, 74.4 per cent.; useful effect of plant, 54 per cent.; voltage, 1000.

ONE of the text-books informs us that the legal definition of a mine includes only "such workings as must be artificially lighted." But why did not the legal luminary from which this ray of wisdom shone turn on a little more candle-power, if it was intended to make everything perfectly plain, and specify further that this artificial lighting should be required only by day? Then there could be no doubt as to the exclusion of all the placer mines and open-cut mines. The laity who have been working such claims under the mistaken impression that they were really mining would like to be sure whether they were or were not doing so, and to settle this serious question the interpreter of the law should be more explicit. As it stands, this definition is about as precise, though hardly as graphic, as the one often used in a derogatory sense, when speaking of a dubious prospect—"a hole in the ground."

CANNEL coal, claimed to be the best of the kind yet found in the west, has been discovered at Vermont station, Missouri. The bed is reported as ten feet thick. Coal of this character commands high prices for domestic use and is often transported over long distances throughout the areas where it is not produced.

CIVIL ENGINEERING

By John C. Trautwine, Jr.

THE importance of the government tests upon full-sized timbers, which have been in progress for several years under the direction of Professor J. B. Johnson, coöperating with Mr. B. E. Fernow, chief of the division of forestry, department of agriculture, is so generally recognized by engineers that Professor Johnson's circular calling upon those interested to memorialize their representatives in congress in behalf of the work, is sure to meet with generous support. The favorable expressions of opinion already made by the engineers of the country, have resulted in obtaining from congress appropriations which have already permitted the accomplishment of a vast amount of useful work, but far more money is needed in order to do justice to the subject, and it is particularly desired that an additional testing laboratory should be established on the Pacific coast, in order that our knowledge of the valuable timbers of that region may be increased. Senators Roach and Proctor are a subcommittee of the committee on agriculture and forestry having in charge a bill appropriating further moneys for the prosecution of this work, and it is earnestly to be hoped that our engineers, who, even more than the rest of the country, have much to gain from these investigations, will make themselves heard in support of the measure.

AS might have been expected, the Benevolent Fund of the Institution of Civil Engineers of London has, like other organizations, felt the pressure of the hard times. Indeed, it has found itself between the upper and the nether millstone, the subscriptions falling off, and the demands upon its services very naturally increasing, so that it has been found necessary to trench upon the reserve account. The income proper during 1892 amounted to about $15,000, of which $7000 were derived from annual subscribers, while the grants made amounted to $20,000, leaving a balance of $5000 upon the wrong side of the account. The total cost of working the fund for the year was about $600, a fact which implies that a great deal of gratuitous labor is done in connection with the work of the fund. The falling-off of subscribers has resulted in a showing that only 13 per cent. of the total number of 5618 members of the Institution are contributors to the Fund, which is a voluntary association established to render assistance to necessitous members of the Institution or to their families.

IN a previous number of THE ENGINEERING MAGAZINE we recorded the death of M. Paul Jousselin, president of the French Society of Civil Engineers. His loss was shortly followed by that of Mr. Charles Herscher, the vice-president of this society, who was taken ill while attending a meeting of the chamber of commerce in January, and who died on the following day. Mr. Herscher had been a member of the society since 1872. During 1893 the society also lost by death M. V. Contamin, one of its past presidents, a man widely known for his scientific attainments.

IN the March number of THE ENGINEERING MAGAZINE brief reference was made to the installation of the hydraulic power-plant of the Niagara Falls Paper Co. by R. D. Wood & Co., of Philadelphia. At a recent meeting of the Engineers' Club of that city Mr. Emile Geyelin, the designer of the plant, presented a paper illustrated with lantern-slides and with a large-scale diagram, describing this important and in some respects, novel work. The turbines, of which there are three, and which operate under a head of 140 feet, take their supply of water from the race of the Cataract Construction Co., while their waste water is discharged into its tail-race. The

water descends from the fore-bay of the turbines through a cylindrical penstock of iron plates and 13′ 6″ in diameter.

As already remarked, the turbines, which are the first hydraulic motors discharging into the great tunnel, are of the inverted pattern, the water entering them from below, so that its pressure counter-balances the weight of the turbines with their gearing and the long vertical shafting by which their power is transmitted to the ground level; and so accurately is this balance accomplished that it is found that when the wheels are running at full gate there is a slight upward pressure on the thrust-bearings, and a slight downward one when they are running at part gate. Indeed it is found that a man, by inserting his finger between the top of the vertical shaft and the horizontal shaft which revolves just above it, can detect the difference in pressure due to the difference in the amount of power employed. The velocity in the penstock, when the wheels are running full, is a little over two feet per second. The three vertical shafts are stayed, at six points between their ends, by horizontal frames of I-beams, while at the top and bottom cast-iron beams are used for the bearings of the turbines and of the gearing by which the power is transmitted. During the discussion Mr. Geyelin explained, in reply to a question, that the object in using cast-iron at these two points was to secure a greater rigidity than could have been obtained by the use of wrought-iron.

As is well known, the falls of Niagara, while much the most stupendous and celebrated, are by no means the only great water-falls in that remarkable region of horizontal strata which occupies western New York. The Genesee presents a remarkable series of falls at different points in its course. Perhaps, from the very reason that they are of less height than their great western competitor, their power seems to have received, up to this time, more complete development. Mr. Cartwright, to whom we have already referred, has recently completed a water-power installation for electric light and power, at Rochester, N. Y., and at the March meeting of the American Society of Civil Engineers he presented a very interesting and instructive description of the work. The fall is of course very much less than that at Niagara, being only feet, and the arrangements are necessarily widely different in other respects from those employed at Niagara. Here the turbines, instead of the shafting, are vertical. During the course of this work Mr. Cartwright has had occasion to make exhaustive studies of the subject of rope-belting, one of the important results being, as might have been expected, that the formulæ for the effect of centrifugal force in reducing the friction of the belt, require complete modification on account of the friction obtained by the wedge-like action of the rope belts in their V-shaped grooves.

In view of the sudden and violent changes of power to which the system is subject, amounting to as much as 100 or 200 horse-power, Mr. Geyelin concluded that the employment of mortise-wheels was absolutely essential, and the blows to which the teeth would be subjected under these changes rendered the use of a hard and brittle material in the driven gears inadvisable and led to the employment of wood. This required the adoption of a large diameter for the wheels and the circumferential velocity of 4000 per minute, which is believed to exceed any heretofore adopted, the greatest on record, so far as could be ascertained, being about 2800 feet per minute.

One of the most serious obstructions to street traffic in Philadelphia is the existence of the main line of the Philadelphia and Reading railroad, crossing at grade a dozen or more important thoroughfares between Broad street and Fairmount park. As the crossings are protected by gates, the danger from passenger-trains is perhaps a less serious matter than the frequent delays arising from the drilling of long freight-trains. Arrangements have now been made for concerted action between the city authorities and the railroad company by which the tracks of the latter will be depressed and the city streets will be carried over them by bridges.

FOR a year or two past, Professor E. A. Fuertes, of Cornell University, assisted by Mr. Rudolph Hering and Mr. James H. Fuertes, has been engaged in an investigation of the sanitary conditions of the seaport town of Santos, in the state of São Paulo, Brazil, and they have recently issued a most elaborate report upon the subject, constituting a volume of 146 pages, besides as many more of specifications. The town of Santos, with a population estimated at about 27,000, is situated upon an island lying about three miles back from the Atlantic coast, some 300 miles west-southwest of Rio de Janeiro. The island is a low, marshy plain, crossed by a range of the granitic foot-hills of the Serra do Mar, or Coast Range. The town has been subject to visitations of the small-pox and other scourges, and, while in some years no yellow fever deaths are reported, there were 1676 deaths from that disease in six months of 1892, giving a rate of 124 deaths per 1000 inhabitants per annum.

The locality was examined by Mr. W. Milnor Roberts in 1881, and this examination, as well as that by Professor Fuertes and his associates, developed a condition of things quite sufficient to account for a high degree of unhealthfulness. There is no efficient quarantine; the water-supply, which is from the hills, comes through pipes of inadequate size, and no proper system of sewerage has been inaugurated. Prior to 1889 the sewage of the town was discharged into the drains and brooks which convey the rain-water from the hills to the harbor, some of which were covered with flat stones, while others discharged through badly-jointed clay pipes, of insufficient slope and capacity, some of them passing under the basements of houses, of course polluting the soil around them. In the year named a contract was entered into for the construction of a sewerage system, which contemplated, among other things, arrangements for sewage-purification, but the system appears never to have been put into operation, and what has been completed of it is very defective, so that the city is still dependent upon the old drains. The intended purification of the sewage, if it was ever practised, has been abandoned. The dead are buried in ground saturated with water. The harbor is overcrowded, but dock improvements which are in progress promise to remedy this difficulty.

The engineers, in the course of their studies of this problem, have visited not only the site in question but many works of sanitation in England, France, Switzerland, and Italy. Their report, which opens with something like a treatise upon sanitation in general, recommends the establishment of a rigorous and efficient quarantine system, an improvement of the water-supply by the substitution of larger mains and distribution-pipes, and the possible addition of other sources of supply, the enforcement of regulations against food-adulteration, the substitution of cremation for burial, improved dwellings for the inhabitants, the removal of garbage, the paving and cleansing of the streets, the drainage of the plain, and the proper sewerage of the city.

The report advises against the artificial purification of the sewage, on account of its expense and of the ample means at hand for proper dilution. The separate system is recommended, with an outfall into deep, swiftly-running water. For one of the three districts into which the town is divided, a district in which it would be impracticable to deliver the sewage by gravity to a point where the pumping-station would be economically available for the other two districts, the Shone ejector system, which has been used in Rangoon, India, at the World's Fair, in the houses of parliament, and in many European and American cities, is recommended.

OUR esteemed contemporary, the *Engineering News*, has introduced into its extremely simple pile formula—

$$L = \frac{2\,w\,h}{s+1}$$

where L = the safe load on a pile,
w = the weight of the ram,
h = the height of fall, in feet,
s = the penetration per blow, in inches,

a modification intended to adapt it for use in cases where the piles are driven with the steam-hammer or with the gunpowder

pile-driver. The modification for the Nasmyth steam-hammer consists in substituting for unity in the divisor the quantity 0. 1, while for the gunpowder driver the coefficient 2 in the numerator becomes 4. The steam-hammer allows only from one-tenth to one-twentieth as great an interval of time between blows as does the ordinary pile-driver, for which the fundamental formula was constructed. Hence, it is argued, the resistance to penetration under the blows, which depends largely upon the time allowed the surrounding material to compact itself, will be but about one-tenth as great, other things being equal, and the factor 1, which, it is claimed, covers these resistances, should therefore be made but one-tenth as great. The gunpowder-driver is similar in its action to the ordinary machine, and the interval between its blows is also approximately the same. Hence the divisor is not changed, but, inasmuch as the force of each blow is contributed not only by the actual fall of the ram, but also (and to an equal extent) by the expansive energy of the powder, which drives the ram up again for the next blow, the coefficient in the numerator should be doubled.

In support of its formula the *News* cites at considerable length an admirable case described in its issue of July 6, 1893, admirable in all but this, that, owing to the desirability of getting on with the work of construction, the loading of the trial piles was most unfortunately stopped somewhere short of the point which would have caused settlement, how far short nobody knows, so that after all the pains taken with this test, it falls lamentably short of its full measure of usefulness.

AT the Old Point convention of the American Society of Civil Engineers, in 1892, the writer submitted a complete list of all the cases he could by diligent search bring to light, in which the four all-important items, weight of ram, height of fall, depth of penetration, and *extreme* load, were given. These results were painfully few in number, and many of them were still more painfully deficient in accuracy and reliability, yet they formed what appeared to be the entire available stock-in-trade of useful data on the subject, and they showed, if they showed anything, that even the two formulæ which, of those examined, made the least forlorn attempt at fitting them, were lamentably at sea, that elaborate arguments upon *a priori* methods are hardly worth the trouble they take, and that close coincidence of any formula with one or more cases really amounts to but little.

AS pointed out at that time, the great difficulty in the use of formulæ for ascertaining the proper loads on pile-foundations lies in the smallness of the penetration and in the difficulty of ascertaining it with anything like sufficient accuracy. This factor is an indispensable one in any rational pile formula, yet it is usually of but small amount, and, from the nature of the case, it is seldom closely determinable, and yet a very small variation in this factor may profoundly affect the result obtained by the formulæ, and it is probably owing to this, as much as to any other fact, that we find such wide and discouraging discrepancies between the best of the formulæ on the one hand and the experimental results thus far obtained on the other.

THE avowedly partisan attack, led by Congressman Enloe, of Tennessee, upon the United States coast and geodetic survey, which institution he seeks to abolish, distributing its duties among other bureaus and departments, is calling forth vigorous protests from the engineering press and from technical societies. The survey is probably as well prepared for a congressional investigation as is any other branch of the government service, but, unless there are better reasons for its abolition than those brought forth by Mr. Enloe, the country can well afford to tolerate its existence for a while longer.

AN old and valued assistant in the survey, Captain Spencer C. McCorkle, was gathered unto his fathers in March last. To those who had the good fortune to know Captain McCorkle, his death will be

a personal loss, for by his kindly courtesy he endeared himself to all with whom he came in contact and from whom his exceeding modesty did not hold him at too great a distance. During the latter years of his life he was particularly interested in the project for developing a line of what he called land-locked navigation for small vessels through the almost continuous line of bays and inlets which line the Atlantic coast from Sandy Hook to Florida, and the Gulf coast to the mouth of the Mississippi. Captain McCorkle urged the great value of such a means of communication in times of peace and its paramount importance in the event of war. He showed also that it could be called into existence by the expenditure of sums ridiculously small in comparison with the benefits which such a system would confer.

HARDLY have the echoes of the failure of the East Providence stand-pipe died out of the technical press when we have reported the collapse of that at Peoria, Ill., accompanied with the loss of one life and the injury of many persons. The pipe had been in use for about four years and had shown no signs of weakness, when, on the morning of March 30, it "burst with a succession of pistol-like reports." At the time of the failure the water was about 100 feet deep and amounted to about 400,000 gallons. Fragments of the plating were thrown to distances of 50 to 100 feet. The velocity of the wind blowing at the time of the failure is variously estimated at from six or eight to thirty miles per hour. It has been suggested by Professor William D. Pence that ice forming in the stand-pipe during cold weather may, by its expansion, have strained some-of the rivet-holes, and that the water, entering these holes and freezing there, may have materially weakened some of the plates.

THE Q. & C. Co. has issued a photographic view of an oak tie protected by one of the company's Servis tie-plates. The tie in question was placed in the 78-foot grade on the Louisville company's bridge over the Ohio river in 1883. In 1889 it was ordered removed, on account of cutting by the rail-flanges, but, as the tie was otherwise still sound, the tie-plates were inserted and the tie allowed to remain. Since that time, it is claimed, no work has been done upon the track. Last year, although the tie, and others similarly protected, were found to be rotting away, the portions under the tie-plates remained sound.

M. EDMOND BARTISSOL, an engineer who was engaged upon the Suez canal, comes forward with a plan for the completion of the canal at Panama. His plan is a compromise between the sea-level project and that for a high level with lifts of from 122 to 175 feet, in that it contemplates a central level 75 feet above the sea, with but two pairs of locks at each end. In order to facilitate the removal of the great mass of material necessitated by this plan, particularly that in the world-renowned Culebra cut, M. Bartissol proposes to impound the waters of the upper Chagres and to bring them by an open channel to the side of the work, whence they would descend through a tunnel, with a grade of 1:1000, to the Pacific. This tunnel, according to M. Bartissol's plan, is to serve as a dump and a carrier for the excavated material.

The shareholders are reported as favoring the project, but the liquidators are inclined to regard it with distrust, arguing that while such a waste conduit might do very well for earth and gravel, it by no means follows that it will be equal to the task of disposing of the heterogeneous materials that may be expected to occur in the great cutting.

DURING the winter of 1873–74 the late and venerable Squire Whipple, honorary member of the American Society of Civil Engineers, erected, over the Erie canal at Hotel street, in Utica, N. Y., a lift-bridge of 60-feet span for the accommodation of the street traffic. The lift consisted of a movable platform, suspended from a fixed overhead truss, and raised and lowered by a man who operated a horizontal tread-wheel placed on the lower deck of the fixed bridge. Ten years later Mr.

William H. Searles, C. E., constructed a wooden lift-bridge of 27-feet span, to carry a railroad over the west branch of the Pennsylvania canal near Jersey Shore, Pa. The bridge was on a skew of 36°, and the trusses, if such they can be called, consisted each of two horizontal chords of 14 × 14-inch white pine, placed only 9 inches apart and separated by wooden blocks. The bridge was lifted and lowered by means of geared shafting, operated by means of a hand-crank. In this case the entire system was raised and lowered, and was not merely a platform as in Squire Whipple's bridge. About the same time a far more imposing structure of the same class was erected to carry the West Shore railway over the Oswego canal at Syracuse. Here the skew was 50° and the clear square span was 52 feet. As in Mr. Searles's bridge, the entire structure is raised and lowered, and, as in all such cases, the moving parts are counterpoised. The power required to overcome the friction is supplied by a small steam-engine placed at the center of the upper deck of the bridge.

THE three structures already mentioned required of course only such moderate lifts as adapted them to their work as canal-crossings, but Mr. J. A. L. Waddell has just erected over the Chicago river, at Halsted street, Chicago, a lift-bridge of 130-feet span, with a lift of 155 feet, through which the bridge can be raised or lowered in less than one minute. Here, as in the other cases, the lift principle was adopted because the narrowness of the channel forbade the construction of a draw-pier in the canal. On each side of the canal is built a steel tower 200 feet high and forming at its base a rectangle about 30 feet square. Of the four legs of each of these towers the two next the canal are vertical, while the other two are battered. The two towers are braced together, at top, by a shallow fixed truss, and between their vertical posts moves the lift, which consists of two trusses spaced 40 feet between centers and carries two lines of street railway track and two footways which are carried outside of the trusses.

The lift is suspended by thirty-two steel cables, which pass over four sheaves on top of each tower and are attached to counterweights which equilibrate the 300 tons weight of the bridge. From the lower side of the lift hang iron chains which are attached, at their other ends, to the counterweights, and which serve to counterpoise the excess of weight of the ascending over the descending ropes, or *vice versa*. The lift is operated by steam-engines placed below the street-level and operating upon it by means of eight 7-8-inch steel ropes attached respectively to the lift and to the counterweights. Underneath the bridge-floor are tanks filled with water, for adjusting if necessary the balance between the lift and the counterweights. The engines working the lift are controlled by a man who occupies a watch-box placed at the middle of the upper deck of the bridge. This box is provided with a "peeper," by means of which the attendant can tell when the lift has risen sufficiently to clear the masts of an approaching vessel, and he is thus enabled to avoid lifting the bridge higher than is necessary. The admission of steam to the cylinders of the lifting-engines is automatically cut off as the lift approaches the top or bottom of its run, and it is then gradually brought to rest by means of hydraulic buffers. The two vertical legs of each tower rest upon pneumatic foundations, while the battered legs rest upon piles, their feet being provided with means for adjustment in case the frames should get out of true.

DR. CHARLES B. DUDLEY, in charge of the department of chemical and physical tests of the Pennsylvania railroad, at Altoona, Pa., has issued, as chairman of the subcommittee on methods of the committee on international standards for the analysis of iron and steel, appointed by the World's Congress of Chemists, a bulletin addressed to those chemists who are engaged in the analysis of iron and steel, urging them to coöperate in the work of the subcommittee by forwarding replies to a series of questions touching matters connected with such analysis upon which general expression is desirable.

MECHANICAL ENGINEERING

Conducted by Henry Harrison Suplee.

THERE has been much foolish matter published in some of the newspapers about the alleged stealing of English designs in marine practice, the statement being made especially that the design of the boilers of the torpedo-catcher *Havock* was being eagerly sought and had actually been stolen by American spies. When it is considered that the construction, not only of these boilers but also of the newer water-tube boilers of the *Hornet*, was fully described two months ago at the meeting of the Institution of Naval Architects by Mr. Yarrow, by whose firm the boilers were built, the absurdity of the insinuations of theft must be apparent. There is a great deal of nonsense in the talk about this matter of secrecy in engineering establishments, for there are few establishments of reputation in which any attempt is made to conceal anything which may be going on. Of course most establishments object to the disclosure of unfinished work, especially when there may be points in the designs which are more or less experimental, or upon which patents may be pending, but when a good design has been carried to successful completion the builders themselves are generally the first to present the results and the details before their professional organizations and place themselves on record beyond possibility of doubt. It is especially worthy of note, in the case of the alleged theft of the boilers of the *Havock*, that they were not as satisfactory as might have been desired, and the design was not repeated. The *Havock* was equipped with two locomotive-boilers of design similar to many others already in use, and these developed on trial only about 3500 horse-power, with an air-pressure of 3 inches. Her sister boat, the *Hornet*, has been equipped with eight Yarrow water-tube boilers, developing 4300 horse-power, with an air-pressure of only 1¼ inches, while at the same time a reduction of eleven tons in weight has been attained.

The nature of the mare's nest which has thus been discovered may be stated briefly as follows: (1) there was little or nothing new about the locomotive-boilers of the *Havock*; (2) they were not altogether satisfactory in their performance; and (3) the construction and performance both of these boilers and those which superseded them in the succeeding boat of the same class had been fully described by Mr. Yarrow himself, before a public meeting of naval engineers, a number of weeks before the alleged theft was "discovered."

THE question of water-tube boilers seems to be coming to the front more and more, and, since the limit of size and strength of "shell" marine boilers seems to have been reached while the demand for higher pressures still continues, it seems as if the water-tube boiler must be called upon to meet the demand, either in its present form or in an improved design which shall avoid some of the present objectionable features. The paper presented by Mr. Charles Ward at the marine division of the International Engineering Congress at Chicago, and the interest in the discussion which it elicited, showed clearly the fact that it is to this type that we must look for the next advances in marine practice. Tubulous boilers have come into such general use for stationary practice that the only considerations which need to be studied for their adaptation to marine use are those of the changed conditions under which they are to be used, and surely the change in boiler construction involved in the use of higher pressures is no more radical, if indeed as much so, as that which has already taken place in the adoption of multiple-expansion engines and twin- or triple-screw propulsion.

EVERY educated engineer will assent to the truth of the statement that power is indestructible, but many will fail to see the many leakages by which valuable power is allowed to run to waste after capture that has cost many dollars. One reason for this oversight undoubtedly lies in the fact that in many cases leakage of power is not immediately perceptible to the senses, so that while our eyes would at once tell of an escape of steam, our noses of a leak of gas, or our ears of an overflow of water, we still remain in serene ignorance of just how much power is running to waste in a journal friction, belt slippage, heat radiation from unprotected surfaces, and all the multitudinous invisible, inaudible, inodorous ways, which, however, are by no means past finding out. The ballad-singer tells us in trite enough words that "the mill will never grind with the water that has passed," but forgets to remark that much of the water has managed to sneak by without performing its due share of grinding. If more attention were given to indicating just how much power was thus leaking away, perhaps more attention would be given to methods of stopping the leaks.

Elaborate calculations have been made to determine just how much power is required to stop a train, but there is an answer to the question which requires no calculation, for it takes just as much power as would start it again to the same speed which it possessed before the brakes were applied. The hissing air-brakes, groaning wheels, and heated brake-shoes all reveal the outlets through which this has escaped, but unfortunately these are outlets only, and never inlets, and as to calling upon this power to help start the train again, that would indeed be a vain call. That such wastages of power might be stored up, to be drawn upon for future use, is not at all impossible. Indeed the very instance of the stopping train admits very readily of just such storage, by placing the station at the crest of a grade just sufficient to bring the train to a stop without the use of brakes, the descending grade beyond giving out to the starting train all that was stored during the stoppage.

Another instance of the waste of power appears in the use of resistance-coils in connection with electric motors which are required to perform variable work, and while, in the present state of the art, such rheostats are found necessary, yet their use is about as economical as it would be to open a blow-off pipe for steam when the load on an engine is reduced, instead of advancing the point of cut-off. A device was once suggested to indicate the increase of friction in the journals of line-shafting, it being simply a paint which changed color when a certain temperature was attained, so that any undue warmth of the bearing was at once made evident to the eye of the superintendent. If some such indication of power leakage could be devised for all sources of waste we might find that there were other losses than those due to cylinder condensation, etc., and other objects which needed "jacketing."

WHEN a man proceeds to make a machine of himself and "perform work, accompanied by certain determinate motions," he begins to realize how patient and much enduring his animal and mechanical servants are. Hence he begins to "kick," in more senses than one, when he tries to ride a bicycle which needs lubricating, up a hill which needs surfacing, when he would have given but little thought to either fact had he been driving under the same conditions. The constant efforts of the bicycle-makers to reduce weights without reducing strength or stiffness, and to reduce frictional resistances by the use of the nicest refinements in ball-bearings and the like are almost altogether due to the fact that man is much quicker to discover the effect of wasteful resistances when he himself has to overcome them than when they are not brought so forcibly to his notice.

These considerations are only partly appreciated in connection with details of machine-design, and while forms of construction suggested by the bicycle are by no means to be considered as applicable to machine-construction, yet it may be worth while to "put yourself in its place" when considering the action of forces and resistances in mechanical structures. Even in

the case of framed structures a much clearer idea may often be obtained of the true relation and action of the parts and forces by considering the whole as composed of human beings, and imagining the manner in which they would be able to meet the stresses and loads. The ingenious manner in which the cantilevers of the Forth bridge were thus shown is familiar to those who have studied the descriptions given at the time of the completion of that great work. An amusing counterpart may be cited in the attempt to explain to the shah of Persia how the electric telegraph acted. He could understand very well that, when a dog's tail was trodden on, the dog barked, and so he was told that the telegraph was like a very long dog with his head in Teheran and his tail in Constantinople. When his tail was trodden on in Constantinople his head barked in Teheran, and so when the key was pressed in one place the sounder clicked in another. The idea may seem ridiculous, but perhaps there is not such a great difference between nerve force and electric force after all, and the parable may have had more truth in it than its author knew.

THE subject of "inspection" is one which may sometimes bear inspecting itself, and, as it is one with which mechanical engineers often have much to do, it may not be amiss to give it some discussion in this place. Nothing, perhaps, is more difficult than the determination of questions involving the character and perfection of manufactured articles, and the position of the impartial inspector may in some cases be likened to the unenviable one of the umpire of a closely-contested ball-game. When the articles to be passed upon are such as can readily be examined the work may become more or less mechanical, and the inspector at an arsenal, for instance, may acquire a skill and quickness of perception which enables him to detect at once a defective weapon. In other cases the mere presence of an inspector is supposed to act as a warning to the manufacturer and keep him on the watch himself, much as a coal-dealer would be most careful to give good weight when he knew that every load was to be re-weighed. These, however, are hardly instances which demand engineering skill or ability. In many cases, however, processes as well as products have to bear inspection, while selected samples to which exhaustive tests have been given are taken as representative of the lots from which they are taken. It is in work of this kind that the ability of the specialist is demanded in the highest degree, and there is no position in which thorough special training and acute perceptions are more necessary.

Unfortunately, inspectors are often chosen for other considerations than those of personal skill or special knowledge of the subject under consideration, and many instances are known in which deceptions have been carried on under the very observation of those who should have seen just what they failed to detect. In some cases articles which have been condemned have been put aside for a short time and then presented again only to pass "inspection" without an idea on the part of the inspector that they have ever been seen before.

IN discussing the subject of aërial navigation it generally has been assumed that the flying-machine should carry its own source of motive power, and many efforts have been made to produce motors of exceeding lightness in proportion to their capacity. While this method must be very desirable for many purposes, it may be worth while to note the fact that, for the more recent forms of surface transit, such as cable and trolley roads, the advantages of central power-houses are prime considerations. It may not be found impossible to adapt some modification of a "trolley" system to aërial transit, thus enabling the power to be delivered to the motors by trailing connections. There is no absolute necessity for high flying, at least for commercial purposes. The real value of such a system would lie in the absence of expensive road construction.

IN this connection it might not be impossible to solve the problem of the abo-

lition of the unsightly overhead trolley-wire for surface roads, by the extension of some such method as that adopted for the purpose of telegraphing to and from moving trains. This, as is well known, is done by the induction action of a current passing through a wire at a moderate distance, upon a coil passing about the car, there being no metallic connection whatever. Could a motor on a car be operated by a current passing through an entirely-buried conductor without the necessity for metallic or other contact, the problem would indeed be solved. This, however, we must leave to our electrical colleagues for their respectful consideration.

REFERRING again to the question of inspection of products and processes, it is interesting to note that while engineer officers of the United States navy are acting as inspectors on most of the work which is being done upon the several warships now under construction, the inspection of armor-plates, both at Bethlehem and at Homestead, has been and now is done entirely by *line* officers, none of this work having been inspected by engineers.

MENTION was made last month in this department of the fact that many engineers in the navy have found it to their personal and pecuniary advantage to resign from the service of a government in which ability is recognized neither by rank nor by compensation. These remarks have since been emphasized by the resignation of Chief Engineer N. P. Towne, in order to accept a position with the Messrs. Cramp, of Philadelphia, at whose establishment he has been acting lately as inspector. The injustice which has been wrought by the distinction of rank between "line" and "staff" officers in the navy probably has as much to do with these frequent resignations as anything else, and the efforts which are now being made by the staff officers to secure absolute, instead of "relative," rank should be crowned with success if we are to have men of ability willing to remain in the service. A modern warship is probably the greatest aggregation of the work of the engineer which can be found anywhere within the same limits of space, and surely methods of organization and discipline should keep pace with the transformations in construction and operation. A fighting-machine must be *fought* by engineers as well as built by engineers, and it may be that the officers of the line will awake to the realization of their false position only to find that there is no further occasion for their existence at all.

THE indicator is to the engineer what the chronometer is to the navigator, and the reliance which is placed in the indicator-diagram should be based upon similar methods of correction and calibration. No horologist attempts to claim absolute accuracy for his chronometers; he is satisfied if he can secure a practically constant rate of error, and this rate is determined and re-determined periodically by comparison at national observatories so that the application of the ascertained correction will enable a degree of accuracy within the required limits to be obtained. A like method of calibration for indicators is entirely in accordance with modern methods, and Chief Engineer David Smith, U. S. N., in his paper before the Engineering Congress at Chicago, very properly observed that to attempt to correct an indicator at the spring is about as likely to prove successful as would be a similar attempt at the mainspring of a chronometer. By using a given indicator to measure quantities of power already accurately known, it is practicable to construct corrected scales for use at various speeds and conditions corresponding to those under which they were calibrated, and thus, by applying the universally-accepted method of working from the greater to the lesser, we may feel confident of the accuracy of subsequent determinations within the range of the original limits of observation.

THE YOUNG MECHANIC

Conducted by Frank Williams.

SOMEBODY suggests that we misquoted Bacon last month. It is not a new thing to take liberties with a familiar quotation and to find in it something that the author never put there. "We are the ancients because we know it all" was not a fair version. We are the ancients, indeed, if there be any, because we have inherited the accumulated knowledge of all the ages; but still are we far enough from knowing it all.

The underlying idea of it, so long ago recognized and formulated, but needing constant reiteration, is that the best informed and the fullest equipped has always the advantage. Stated mechanically, it means that if if we are are to work and win we must have a full kit of tools. Looked at in a business way, it means that we must have capital to carry on the business of life successfully. The individual young mechanic, as much as the biggest merchant or manufacturer, must have and must continually accumulate capital or he can't get along. We should always be able to do not only what we are now doing but more and bigger things bye and bye. Who knows of any established and prosperous business that is not also and always a growing business? Sometimes it may grow faster than at other times, but it is the almost universal law of business life to either grow or die. There is no such thing, for a very long time, as just barely living. If we could remain stationary, things around us would not. "Marking time" or rowing against the stream without gaining on it is never kept up for very long.

WE hear much in these days of the continual narrowing of individual occupations. We hear, what is the simple truth, that every worker and every student is becoming continually a more minute specialist. Some young fellow may take this the wrong way. He may say that as he is a mechanic and seeking the fullest equipment for mechanical occupation he must read and study nothing but what is strictly mechanical, and so may think it his duty to actually narrow the range of his knowledge. In these days we each learn to do the one thing instead of the many, but we are apt to find that to do the one thing well we need to know more than in the olden time we needed to know to do the many things. Raising water is one of the primitive occupations, and if it be lifted in a bucket there is not much to know. There may be some choice in the size and shape of the bucket and in the best adjustment of the handle of it, and that is all. But to lift water to-day we must know all about the complex, high-pressure, multiple-expansion, condensing pumps with exhausting reports. That is the way in which some of our occupations have "narrowed."

The fact is that to know the one thing completely we need now to know everything and a little more. Here is an illustration on the spot. Not every mechanic who saw *Harper's Magazine* for March of this year saw more than one mechanical article in it. There were in fact two, without even hinting at a third one. Probably even the editor of the magazine in making it up thought the second article referred to a good set-off or contrast and as far as possible in topic from the pronouncedly mechanical article upon "A Steel Tool." Thet mechanic must have been hopelessly lacking in that true, wide-reaching, all-embracing, instinctive interest and sympathy that belongs to him if he did not at once recognize as his true food "The Welcomes of the Flowers," by Hamilton Gibson. The article about steel of course every mechanic who saw the magazine felt it his duty to read. Those who were well informed upon the subject had to read it to see that it was all right and those who were not so well informed had to read it

for the sake of what they could learn. If any pseudo-mechanic then looked through the magazine and did not "catch on" to the flowers his case is a deplorable one. But from a mechanical standpoint what was there that should especially interest us in "The Welcomes of the Flowers"? First, then, there is in the true mechanic the ability to appreciate excellent work wherever it is found, and none the less if the work be widely different from his own. Who ever saw such dainty art work as Mr. Gibson's pictures of flowers and insects? They have their full right to be merely in the pleasure they give to those who may be allowed to see them. But as illustrations of nature's devices for the performance of a necessary mechanical function they have their special interest for us. We learn from them more of the interdependence of created things, and that a flower cannot live an independent individual existence any more than a mechanic can. By the "welcome" of the flower is meant its invitation and welcome to the insect whose office it is to effect its fructification, and without whose visit the flower must die and leave no successor upon the earth. The flowers to secure the visits of the insects offer their inviting cups of honey, with gay colors and pleasant odors to attract, and lines pointing unmistakably to the storehouse of the sweets; but when the insect comes the flower plays its little trick upon him and sends him off bearing the fructifying pollen to some distant flower, and thus the work of cross fertilization is kept up. The endless variety of ingenious mechanical devices (most of them patentable) for accomplishing this purpose cannot fail to find appreciation in the true mechanic who will look into them, and cannot fail to be of help to him in his mechanical education and development. And then when we have taken our fill of these ingenious mechanical devices merely as such it will be strange indeed if the function that they perform does not itself offer its pregnant suggestion to us. How about the cross fertilization of the mechanical mind? Of the fruit already garnered in our modern life how much of it all has come to its ripened perfection and bestowed its richness upon us but through the cross fertilization of the human mind? What are we doing and what shall we do for the promotion of a function so necessary and so beneficent?

He that knows only just what he himself knows knows nothing. He must find some source or many sources from which to fill up or he will blow away, or he should be blown away. Much may be done by reading and study. We don't read many books now, they say; still we read much and we pick up much as we read. What used to fill the books now fills the periodicals of the day, and it has a wider distribution than ever before; and between those who get it and those who do not get it there is a boundless difference. Still there are many things that are not caught, or not easily caught, in this way. And not only "things" are missed but more especially the true inwardness and spirit of things are missed. We distinctly favor the journeyman idea. Every young mechanic should if possible—and why impossible?—see other shops and other work and other ways than his own. He can not only get items of knowledge or practice that are too familiar to be mentioned in print, yet far too vital to be missed, but he will also be generally spurred up and quickened if he has anything in him. The best pace is never got out of the racer unless somebody is after him. Besides all that the young man gets as he goes along there is also what he carries, and which he can bestow where he will, and which he often unconsciously distributes and still is none the poorer. The bee thinks only of honey as he goes, and not at all of cross fertilization, and so the young mechanic may think only of looking for a better job here and there; still there is little doubt that if he be one whose work and influence would be of value in any fixed place they are enhanced by a wider experience and contact.

We are far enough from counselling the young man who is doing well and is appreciated to rudely sever his connections and cast himself adrift on the world. He

may, however, keep his eyes open for all chances of visiting other establishments as he has opportunity, and he may plan his vacations and excursions so that they may add to his chances. He may thank his lucky star that he is in a land that is unique in its opportunities for seeing and knowing. We think much of the open-hearted and liberal policy that has always prevailed in our country. As a rule the visitor has had the freedom of the American workshop so far as the study of means and methods was concerned. We have no trade secrets that all the world may not know. There is no doubt but that this liberal policy has contributed greatly to our general advancement. As industrial plants become larger the requirements of discipline seem to call for tight fences and watchmen at the gates, but we will be sorry to see our workshops like the sealed establishments of the old world.

THE United States government sets a noble example of our characteristic unsuspecting and generous and unostentatious habit. The other day we went through the formality of asking for a pass to visit the gun-factory at the Watervliet arsenal, and we have been wondering ever since what the pass was for. We had no use for it. We were free to go wherever there was anything to be seen. We could see whatever we would of the splendid equipment of machinery and the monstrous and marvelous guns, in all their details, and in all the stages of their production. It is very certain that we could not have done the same anywhere in Europe; yet what is gained by all their childish precautions, and what is lost or risked by our open-hearted confidence and liberality? Any reader of this may see as much as we saw. We have always found ourselves free to visit all similar government establishments anywhere. A visit to Washington is a pleasant memory always, for the hospitalities of the government departments and the sense of proprietorship that is everywhere suggested to the visitor. Proprietorship without care is as far as the antipodes from the care without proprietorship that is familiar to most of us.

As we are surrounded with opportunities both public and private, we will avail ourselves of them when we can, and if it comes to us to change our field of activity and usefulness we may regard it as a move in our favor rather than otherwise.

NOW here is a young fellow who has overdone the business. . Even good advice is to be followed with judgment and moderation. We knew the writer of the following letter as a young pattern maker of say average ability working in a shop with which we were connected in New York. The letter it will be noticed was written at Chattanooga, Tenn. Our reply was despatched with reasonable promptness but it failed to find the young man who had by that time gone to Chicago, and it came back to us, like Noah's dove, while he is still flying over the land in the vain hope of learning all there is in it.

WE happen to possess in active intensity that true mechanical instinct, that by the unreflecting is often called laziness, but which is in reality a form of self-respect and appreciation; we mean the aversion to waste exertion or to allow anything when done to fail of all effect; and so if we ever write anything it goes hard with us if we do not eventually compel some one to read it, or if they don't read it the sin is upon their own consciences rather than upon ours. Here follows the correspondence:

DEAR MR. GRUMBLER:

I beg pardon for taking the liberty of writing to you, but as you occasionally help out young men with your etc , etc., I thought that you would not be offended and might be willing to help me.

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at that trade at Maltster's or at any other place in New York? My age is twenty three and I have worked, as I said, at two trades already, and am quite certain that I could do the same or more in two years than some would do in four years serving. (The writer of this letter was not of American birth.) Do you think firms would make an allowance in this respect or employ only under certain fixed rules?

Wishing you a Happy New Year and thanking for your favor, I remain yours respectfully,

OMNIVOROUSAMBITIOUSCUS.

Chattanooga, Tenn., January 1.

OUR REPLY.

MR. O————SCUS:

Dear Sir: I thank you for your kind wishes, and heartily reciprocate the same. Your determination to push yourself along is the correct idea, and your confidence in your ability to "get there" is not a bad thing to have, and I would be glad to help you. I think, though, you are making a mistake in trying to become a Jack-of-all-trades. He is a fellow of whom I never heard a good word spoken, and I do not know that he ever deserved a good word. The world has no use for him, and the deliberate and established opinion of the world is one of the most reliable things in the world. Adam had a perfect right to be a Jack-of-all-trades; but he should have been the last of the race. Ever since his day the trades have been dividing and subdividing and narrowing, and therein have found all skill and excellence and success. If you are as successful in life as you of course hope to be, you will bye and bye have a house of your own, and then naturally you will do your own plumbing and paint your own pictures, because by that time you will be able to do all these things, and as you do them yourself you will of course do them just as you want them and you should be a happy man. Then, again, things may not turn out just as you expect, and it may be as well to travel in the good old ways. It would be better for you, it would bring you better wages now and open a better chance for you in the future if you would stick to one thing, and I don't know any trade better to stick to than pattern-making. It seems to me strange that you, being a pattern-maker, and anxious to get along, do not see that closely allied to it are drafting on the one side and molding on the other, and that you should look in these directions to supplement and add to the skill and knowledge you have already acquired, and make it all count together for your substantial advancement. An expert molder is very unlikely ever to be an expert pattern-maker, but nobody is better fitted for a critic and teacher of pattern-making, and no pattern-maker is more than half a pattern-maker if he does not know much about molding. Then the pattern-maker has to know about mechanical drawings, to be able to "read" them, and to follow them accurately in his work, and he should also be able to make a drawing, and the better he can do it the better it will be for him. Good draftsmen to-day come some of them from the work-bench and some of them from the technical school, and, so that they arrive in good condition, it makes little difference from which direction they come. The draftsman, when he has become reasonably expert with the drawing, may turn his attention to the study of the thing drawn, and then the whole field of mechanical industry opens before him, a field so wide and vast that he can only hope to invade some chosen section of it. The thing to be always borne in mind as most essential is thoroughness and completeness in the pursuit of the thing at any time occupying your attention.

Referring to your specific question, I would say that it is difficult to get a chance to learn blacksmithing anywhere, because no one can spare a fire for a beginner, and I don't suppose you could make any arrangement to begin the trade at such a place as Maltster's carriage factory, and if you got in there you could not acquire skill as fast as you could in a little busy jobbing shop. Expert all-around individual workmen are not produced in "factories" and are in little demand there.

I of course do not know just what you propose to make of yourself, or what you think of fitting yourself for, but I cannot imagine any mechanical position to be filled the fitness for which would be best promoted by the all-around trade practice that you propose for yourself. An able superintendent or proprietor may and often does become an excellent critic of all the men under him and of what they do, but that is a very different thing from being able to do everything himself.

I like to speak plainly what I think, and that seems to be all that I am able to do for you, and if it helps you at all I shall be glad.

Yours truly,

DYSPEPTIC GRUMBLER.

THIS style of young man comes along very frequently looking for a job and telling you that he has worked in most of

the prominent shops of national reputation in your line of business in different parts of the country, giving the names of firms familiar to every one and often volunteering additional particulars about their shops and shop methods. It is sad to say that these peripatetics do not always tell the exact truth about their travels and workshop experiences. We, however, pride ourselves upon our ability to always exhibit a bland and childlike faith in the veracity of every narrator, and in these cases we generally tell the applicant that the firms they speak of have attained their success and eminence by retaining their most promising workmen and not by scattering them over the land, so that it is no recommendation to say that you have been in the employ of many prominent firms unless it is also clear that you have trailed a broad streak of regret behind you. Business capital in manufacturing consists not alone in money in the bank, in fine and roomy buildings, in the most improved machinery or in the best and fullest facilities everywhere. Much also of manufacturing success has lain and still lies in the accumulation and retention of skillful and experienced and faithful employés. When an establishment is closed for an indefinite period, and the men are scattered and lost to it, it may be possible to start the engine and shafting and machinery at a day's notice, but for lack of the trusty men it may be long before everything is running again with its accustomed smoothness, reliability and profit. When a pessimistic spasm comes over us as a people, and we get a little taste of the calamity our foolish fears have fostered, and the industrial establishments are closed, and some worthy men are taught the bitter humiliation of having to "beg their brothers of the earth to give them leave to toil," we have to some extent a new deal in skilled labor, and one employer's calamity becomes another's opportunity, and between them the valuable mechanic is not long left out in the cold.

WHILE we are going along trumpeting the praises of the present as being in truth "the good old times," if there ever were any, some folks will be accusing us of being too optimistic; so as to balance things, and to make these good people happy by showing them that they are not really so well off after all, we will have to give a little of the other side of the case, and the way to do it is something after the following fashion. It happened to us in our youth to be a neighbor to a little wiry Frenchman who had two little daughters whom he set out to drill and train into accomplished musicians. Their exercises were begun as soon as they could walk and talk, if not before that, and were kept up incessantly. When they were at the piano their father stood over them with a little rattan to rap their knuckles if a mistake was made, and, whatever may have come later, their earlier years were not happy ones; but as the result of the unrelenting discipline one of the little musicians became Madame Albani. We once saw a very little child brought on the stage all doubled up in a carpet bag, and that little child is now perhaps the greatest of living contortionists. So it is with each supreme instance of excellence, whether in art, in acrobatics or in mechanics. Art is long and life is short, and there is no time to waste, and our training should begin in our tender years. There need not be cruelty but there should be opportunity and constant exercise tending in the direction of the successful life occupation. In this view of the case the life of the incipient mechanic in these latter days is not all that it might be, and he doesn't have the start that he might have, nor even such a start as he would have had if he had begun his active career in the fifties or the forties or away back. One American institution that was the nursery and the primary school of the American mechanic has disappeared or is rapidly departing from all our towns and cities. The woodshed has gone forever where we used to tinker and invent and make boats and kites and windmills and waterwheels and wagons and churns, and where we used to have shows of various kinds and meetings to organize societies or get up imposing processions. It has gone never to return and nothing has come into the life of the budding mechanic of

to-day to take its place. Two or three years ago we were in Minneapolis and we found the institution still maintaining a struggling existence there. On one we saw a sign announcing a circus that was to be held "next Saturday, all day, admission ten pins," and we were sorry that we were not able to attend. On another one there was a sign "Punkins dugout, Lanterns for sail." The price was not given or we might have bought one. This is meant in all seriousness. We have no doubt, in fact we know that the American woodshed has evercised an important function in the development of American mechanical skill and its departure is to be regretted.

The attic, where it exists, is no substitute for the woodshed. It may do for the individual tinker but there is not the freedom for the neighbor boy to come and go as he will, and when it comes to invention, or to execution either, one boy is to two boys as $1:2^5$, and from that upwards according to the boys and other things. With the attic also there is not the freedom as to noise, nor the freedom as to matter out of place, so that it carries with it limitations that are fatal to any worthy developments. We hear sometimes of attic philosophers, and for such cheap stuff as that it may do; but we are not likely ever to hear of the attic mechanics.

COMMENT & CRITICISM

A National School of Mines.

IN the February issue of THE ENGINEERING MAGAZINE I was much interested in a criticism by Mr. Richard A. Parker, entitled "The Cost of Mining Schools." While he takes occasion to make a severe and a rather "one-sided" comment on the folly of the establishment and state maintenance of so-called mining schools in the west, the subject is doubtless a timely one, and certainly calls for opinion from more than one quarter, although Mr. Parker evidently takes it for granted that his view of the matter, as given in his published comment, will be accepted as final and decisive. It would also seem that Mr. Parker, while making no direct allusions, advocates the total abolishment of all western mining schools and unmistakably intimates that the Columbia School of Mines possesses all the essential requirements for a national school for the training of mining engineers. The New York school is unexcelled as a technical institution for the theoretical training of engineers, but the fact should be apparent to Mr. Parker that the location of this school on the Atlantic coast, so far removed from any important mining region, would preclude the idea of its ever becoming a "Mecca" for mining-engineers-to-be.

In the United States to-day no medical student can receive his degree without having had actual practice in the hospitals, nor are any naval students graduated from Annapolis who have not served their term on ship-board; but it is nevertheless true that young men being fitted for a profession equally as important—*i. e.*, mining—*can be*, and undoubtedly *have been*, graduated from the New York school without ever having been inside a mine, excepting a few possible trips to some neighboring stone-quarries and collieries. But, in the face of all this grave neglect of the practical part of their education, these same young men, after securing their degrees, are frequently intrusted by mine-owners and capitalists with positions of the greatest responsibility, to which fact, undoubtedly, some of the heavy losses attendant on so many mining enterprises are directly traceable. Such a man as this, with his degree of E. M. in his pocket and no practical experience whatever, must necessarily spend two years or more at actual work in the mines before he can gain even a fair idea as to what constitutes the duties of a mine-superintendent.

It is generally and rightly conceded that the most reliable and successful mine-superintendent of to-day is the one whose training embodies the practical as well as the theoretical part of his profession, the one being of little value without the other. But, as can be imagined, a miner at work underground has no time to devote to the study of calculus, hydraulics, and mechanics, nor can the student in our eastern technical schools spend any time at practical mine-work and at the same time maintain his class standing.

The truth of these statements will be evident to any one who knows the least thing about the subject, and it seems hardly necessary to add that a satisfactory solution of the question can be had in meeting the demands of theory and practice each half-way and establishing a large, well-equipped mining school at some point where mining is the chief industry, in the midst of some district where, for a hundred miles in all directions, are mines of gold, silver, lead, copper, zinc, iron, and coal; where monster smelters rear their tall stacks in nearly every town; where the atmosphere is laden with smelter smoke; where every other man depends for his livelihood on mining and its allied industries; where, in fact, the very rivers and streams are discolored with the waste of mines and stamp-mills and reduction-works. As a

student amid such scenes, what ideas would be imbibed, what grand lessons would be learned, and, above all, what enthusiasm and interest would be aroused and stimulated by witnessing daily such practical illustrations and demonstrations of the lectures and theories of the class-room.

Such a location as mentioned is not ideal, alone, but both real and possible, there being not a few places in the United States where mining and metallurgical interests are so concentrated around a common center as to offer inducements for the establishment of a national mining school that are vastly superior to any advantages that could possibly be afforded by a seaboard city like New York. It may be mentioned that no state in the union has stronger claims for recognition in this respect than Colorado, which, as its mining and smelting statistics show, surpasses all other states in the vastness and wealth of its iron and manganese deposits, its coal-beds and its mines of gold, silver, and lead, together with the mills, smelters, and reduction-works that are necessary adjuncts in the treatment of these products.

There are only three mining schools in the country to day that take an active part in the education of reliable mining engineers and metallurgists—the schools at New York, Golden (Colorado), and Houghton (Michigan). The geographical, and I might say geological, location of the former school is greatly to its disadvantage, as stated, but were this excellent institution so situated as to render accessible at all times to its students all kinds of mines, metallurgical establishments, and the long train of industries pertaining thereto, much of the talk about incompetent "specialists" (so-called) would soon cease. As things now are at Columbia almost all the mining and metallurgical operations and methods are taught and illustrated by means of models and charts, which, though of great value to the student in showing him *why* such and such an operation should be done, cannot, for a certainty, give him any very definite idea as to *how* it is done; for the countless small points and details which are continually being observed in actual practice cannot be explained by any such system of maps, models, and charts as are now in vogue at this school of mines. A student can easily learn from his text-books, lecture notes, and models how to build a cupola furnace, but the ability to mend a broken slag-pot or remodel an old mill or smelter cannot be derived from the same source. These are things which he must learn for himself after he leaves college and goes to work in the mines, but they could just as well have been learned during his student life IF his college had been so located as to bring its students into intimate contact with the very things they are striving to learn about. A well-known western engineer once said "it is just as easy to learn how to mine from charts, models, and such as it is to learn marine engineering in a barn-loft on a Kansas ranch." The truth contained in this terse remark is not hard to realize.

Of the Colorado School of Mines too much cannot be said in favor of its location, which is certainly superior to that of any other mining school in America and probably in the world. Its growth has been steady though hampered somewhat by adverse legislation, as is inevitably the case with state institutions. Its popularity, however, is increasing yearly and had its financial resources been less limited it would long ago, as it is even now inevitably destined, have taken front rank as a school where both the theoretical and practical training is relied upon to produce that most desirable of professional "products"—a mining engineer who, from the outset, is actually able to distinguish between a lead-smelter and a quartz-mill, and who, moreover, does not possess an endless array of class-room theories which have to be "unlearned" before he can become of any service whatever, around a western mine, at least.

An hour's ride in any direction from this Colorado school will take the student into the very heart of the greatest smelting district in the United States, while a day's trip at the most would enable him to investigate for his own satisfaction and instruction anything in the way of mining

and metallurgical methods or operations he may desire.

The Houghton school is considerably the smaller of the three but possesses an able faculty and an admirable location in a region where mining is conducted on a scale unequaled by any other part of the world. The chief drawback here, however, is due to the fact that all the accessible mines are either iron or copper, with practically little difference in their workings and methods of operation, so it is no more than reasonable to suppose that the graduates of this school know little or nothing about the mining or metallurgy of the precious metals excepting such theoretical knowledge as might be acquired in the class-rooms.

It will be observed that each of these institutions has its own peculiar advantages and well serves the purpose for which it was originally intended, but when it comes to a question of a National School of Mines every effort should be made by those interested to have erected and equipped such an institution for the training of engineers as will serve as a model for all nations. Last, but not least, there should be embodied in its *situation*, construction and equipment all the essential features and important advantages of those schools now in existence with *none* of their defects and disadvantages.

PERCY WILLIAMS,
Editor *School of Mines Scientific Quarterly*.
Golden, Col., March 1, 1894.

Preservation of Metals from Corrosion, by Electric Polarization.

A PARAGRAPH in the April issue of this Magazine recalls to the undersigned suggestive points that have been in his mind for years. The paragraph referred to is one in the department of "Mining and Metallurgy" relative to the corrosion by *mine-waters*, of metallic surfaces exposed thereto.

The class of evils here exemplified is very widespread, indeed. It is not only in mines that iron and steel meet their chief natural enemies, water and carbon-dioxid, or rather—when the water and carbon coëxist—their one worst enemy, carbonic acid. Metallic salts and acids in mine-waters intensify the corrosion, by decreasing the resistance of the water to voltaic circuits, the corrosion of metals by liquids being voltaic phenomena, in all cases. Acids and acid salts, which, are capable of taking up iron oxids into solution, still further enhance the destruction, by removing such oxids—which would otherwise remain more or less a protective coating. But the saline matter in solution, that exalts the voltaic action, need not be acid. Any *neutral* salt which decreases the resistance of the water will qualify it to act as the necessary liquid medium of a voltaic circuit. Sea-salt is the commonest of all such neutral salts. Together with other chlorids and the sulphates of sea-water, it enables corroding voltaic action to be set up on all iron and steel surfaces immersed therein.

But the question may arise with some, how can a voltaic circuit exist where *but one metal* is present? Two metals, whose affinities for oxygen differ in degree, are needed. True, but are we considering a case of but one metallic surface continuously uniform in its affinity for the oxygen of the water? Practically *never*, in case of the ordinary forms of iron and steel. Their surfaces are never homogeneous in composition (that is, in proportions of carbon, silicon, sulphur, etc.), or in density, crystalline character, electric conducting power, and so on. The tendency of chemical and microscopic researches is cumulative in this direction.

And the moment corrosion begins, this heterogeneity of surface increases. It is a familiar fact that when a corroded spot appears, it must at once be rubbed off, or polished out, or it spreads. "Rust eats into metal." The trouble referred to in Mr. Williams's Department is not therefore by any means one peculiar to mines. All our iron and steel *vessels*, inclusive of their hulls, machinery, and boilers; indeed all steam boilers and steam machinery, on sea and land; all iron buildings, iron and steel bridges, inclusive of suspension bridges; all iron roofing, iron fencing, iron paving, and all underground iron mains, especially water-mains, are more or less

liable to this same destructive agency, of voltaic corrosion.

This agency, as shown by numerous developments of modern research, is not confined to the superficies of the metal. Minute flaws, pores, and fissures are very liable to occur in masses of iron and steel, which, though imperceptible to the eye, will admit liquids; and it has quite recently been shown that, by reason of the want of homogeneity already referred to, *thermo-electric* currents arise within such masses during every change of temperature. Such currents must set up voltaic action within such cavities or fissures, which, though slight, will in time enlarge these cavities sufficiently to sap the strength of the mass. Wire cables, so often used for hoisting in mines, as elsewhere, are liable to such insidious internal corrosions, and calamities have thus arisen.

The mode which the present writer has to propose, to obviate and largely diminish, if not altogether terminate, these dangers and losses, and ruin of costly structures, is to muster against them electric energy itself—figuratively, to "fight fire with fire." If a mass of iron is exposed to the corrosion produced by superficial or internal voltaic circuits, such metal is to be made, as a mass, the negative terminal of a much *stronger* circuit, from a dynamo-electric engine, while the corrosive liquid is made to bathe the positive terminal of such stronger circuit.

Many mines and most iron steamers are now provided with electric generators, and this protective agency may in numbers of cases be applied with little additional cost. The currents required, short-circuiting being of course excluded, will not be large.

For mines, a small generator, operated by some small water power, which will work night and day, will be best. The positive pole of such generator should be carried through an insulated wire down to the lowest pool of water in the workings on which the pumps operate (terminating in a body of hard-burned coke), while branches of insulated wire from the negative pole should be carried down a shaft, and thence through every gallery, with frequent points of attachment for branch wires, which may be connected permanently with fixed metal articles, as lines of rail, drilling-machines, pumps and pipes, ladders, etc., and temporarily with movable articles, as iron cars, wheels, tools, etc. In one case, that of "fiery" coal-mines, this plan may not be feasible, for obvious reasons.

In the case of iron-vessels, the hull must be made negative, as well as the boiler-shells, the cylinders, machinery, shafting and propellers; while the positive pole will pass into the open sea, with a terminal of large surface, of hard carbon. In the case of plain boilers, without many flues, their water may have immersed therein a large flat plate of battery-carbon, with glass supports, attached to an insulated negative terminal wire which passes through a hard-rubber plug set in the boiler-shell. In the case of marine condensing engines, no *incrustations* should form on this carbon by electrolysis, which may with ordinary waters prove an obstacle; though such electrolytic incrustations are not likely to be hard and stony, like others. As for any acids, or even chlorin, if such should possibly be freed by electrolytic action, these could do no harm either to boilers, valves, or cylinders, so long as the latter are all kept in the electronegative state.

With reference to corrodible metals in general—other than iron and steel—space permits but the remark that the principle is applicable, in duly modified form, to all these likewise.

HENRY WURTZ, PH.D.,
No. 2149 Seventh avenue, New York.

Costly Economy in Railroading.

MR. SIMMONS'S very clear and conservative paper on "The Outlook for an Improvement in Business," in the April number of THE ENGINEERING MAGAZINE, contains a paragraph on the railroad situation which seems to call for further remark. The writer says:

> It is true that the railroads which have not been embarrassed show a heavy decrease in gross earnings, but there has been a corresponding heavy decrease in operating expenses, as a result of which, in some instances, the current reports

show an actual increase in net earnings. This would indicate a comparatively healthful state of the financial condition of the railroads.

On the face of bookkeepers' balance-sheets and net earnings that may be quite true in one sense, but the statement needs some qualification. There are other considerations to be taken into the account, which do not appear in the companies' current reports, but which are bound to make themselves felt in the long run and which have already begun to show injurious effects. Further on Mr. Simmons adds:

> Another favorable feature of the situation grows out of the economy which the railroads have been practising. Since the date of the Baring failure, in 1890, the railroads have been reducing expenditures—a fact well known to those in the business of selling supplies to railroads—and since the panic of last summer they have been forced to the very limits of the most rigid economy.

Mr. Simmons explains that the railroads "must soon be in the market again for supplies"; but that is putting the case very leniently. Many of the roads have shut off repairs and renewals of line and equipment to a most hazardous extent. A well-built road, starting with its track, bridges, rolling-stock, and miscellaneous equipment in the best of order, with the usual reserve supplies on hand, can be operated for a certain short period, say a year or two, on its existing plant, with very small outlay for keeping up its condition. But that time of grace speedily runs out. Whatever is then seemingly saved has to be made good sooner or later, for the original plant rapidly deteriorates under such a policy. In the end the cost of putting a road back into full effective shape by one general overhauling is likely to be greater than if the repairs and renewals are kept up *pari passu* with the wear and consumption. But meanwhile a more serious trouble comes in—the increased number of accidents, or at least those justly attributable to depreciated plant and underpaid labor. I have no recent statistics at hand, but it is a matter of common remark that railroad accidents have multiplied of late,—especially the minor ones. Observation in a railroad center whence there are many radiating lines clearly shows this. Even the newsboys here have got into the habit of calling out as the stable inducement to buy the evening papers, "Terrible wreck on the ——— road!"

Those roads which are now in the hands of receivers are being operated with a more cheese-paring policy than the financially stronger lines. In reducing wages they have not caused as serious strikes as would occur at other times, for the men recognize the necessities of the situation and are themselves in poor shape to inaugurate a contest, while there is so little other work for them to turn to. But when "economy" is pressed too hard upon men of such grave responsibility as train-despatchers, telegraph operators and others to whom are entrusted the lives of thousands and the property of the road, and who are overworked and discontented (if not replaced by inefficient men), the results are inevitable. "Rigid economy" goes too far when it forbids the renewal of broken signal lamps. Life, limb and property are things that have to be paid for; and the longer the present system is continued the greater will be this concomitant drain upon the companies' resources. It must be remembered, too, that before this era of ultra-retrenchment had begun, fierce competition had forced railroad managers to as close regulation of expenditures as was prudent. To go beyond this was unsafe, as is already amply shown. Of course managers understand this fully, and their action is by no means a matter of choice.

A PASSENGER.

CURRENT TECHNICAL LITERATURE

MACHINERY FOR METALLIFEROUS MINES: A PRACTICAL Treatise for Mining Engineers and Managers of Mines. By E. Henry Davies, F. G. S., E. M. With upwards of three hundred illustrations. London: Crosby Lockwood & Son. New York: The D. Van Nostrand Co. [Cloth. 8vo. xvi-564 p. $5.]

THIS volume is designed as a companion to the well-known work on "Metalliferous Mines and Mining," by the late Mr. D. C. Davies, F. G. S. (whose son the author is), and is devoted to the description of the various machines and appliances in use in mining, both for the extraction and transport of the ore and for its concentration and preparation for market. The author qualifies this by limiting the scope to "machines in daily successful use"—a point well taken, and in the main adhered to. He further explains that it does not "attempt to exhaust the list of the numberless new processes and new patents which the fertile brains of inventors are almost daily bringing before the public, only too often to attract a brief attention and never to come into practical use." Indeed, as it is, the feature which will first strike the reader is the perhaps too-extensive field sought to be covered by a single volume; for mining machinery proper would seem to be quite large enough a subject, without attempting to include matters which might better be left for another volume on metallurgical methods and appliances. But it certainly is a pleasant relief to note the omission of descriptions of antiquated and merely tentative devices, usually quoted with wearisome repetition in similar works; and the author has done wisely in giving his main attention to actual modern practice. In this respect the book is more nearly up to date than any other compilation of the kind, and therefore commands high appreciation.

The subject-matter is arranged under the following heads: Water as a motive power; wind-engines and ventilating machinery; steam-boilers, steam-engines, and oil-engines; hoisting machinery; the drainage of mines and pumping machinery; rock-drilling machinery; boring apparatus; coarse and fine concentration machinery, sizing and classification trommels, jigging, etc.; the milling of gold-ores, milling of silver-ores, amalgamating plates and machinery; the chlorination and cyanide processes for the extraction of gold; concentration mills or dressing floors for the ores of lead, zinc, copper, etc.; electricity as a motive-power for mining-machinery; electric lighting and blasting; aërial wire-ropeways and wire-ropes; and transport by rail and road. This mere outline at once calls up an impression of the magnitude of the task undertaken.

The sections on steam-pumps, etc., contributed by Mr. Philip Argall, of Denver, are particularly good. The series of chapters on concentration are also well prepared. The compiler seems not to have drawn so largely as is unfortunately the prevailing custom upon older and partially obsolete reference-books, but has followed current literature and the experience of himself and associates. Possibly in some cases he has relied too implicitly upon the trade circulars of foundries and machine-shops; but this is the simplest way of keeping abreast of the times in mechanical progress, and such publications have latterly become very useful.

Careful as Mr. Davies has been, it was inevitable that many omissions should occur, which will be suggested to technical readers, while some of the matters briefly discussed deserve treatment in more detail. It may seem captious to object to anything in a work so admirable, but one cannot but regret that the sections on gold and silver amalgamating-mills were not stronger. Silver-milling is not dead yet, in spite of being steadily supplanted by

smelting and other methods. But it must be remembered that any one of a dozen sub-topics touched upon would in itself furnish a theme and material sufficient to fill a more bulky volume.

The field is viewed through English spectacles, but there is a great deal concerning American practice and continental practice as well. In style the text is remarkably clear and concise, free from pedantry, and easily intelligible to all who will have occasion to consult the book. The typography also is good, though a few slips have been allowed to pass.

ALBERT WILLIAMS, JR.

ALTERNATING CURRENTS: AN ANALYTICAL AND GRAPHICAL Treatment for Students and Engineers. By Frederick Bedell, Ph. D., and Albert Curling Crehore, Ph. D. Second Edition. New York: The W. J. Johnston Co., Limited. London: Whittaker & Co.. [Cloth. 8vo. 311 p. $2.50]

MESSRS. BEDELL AND CREHORE have been prolific writers upon the growing subject of alternating currents and their phenomena, and their articles had already gained them a reputation of the first rank in this important branch of electrics prior to the issue of the first edition of this book. While some of their contributions to current literature have shown them fully capable of handling the subject from a purely mathematical standpoint, others have shown them to be possessed of that rare quality of describing in simple terms the phenomena and reactions which are to the mathematician most easily explained by mathematical expressions not intelligible to others than those fully equipped in the higher mathematics. This second edition is almost an exact reproduction of the first necessitated by the early exhaustion of the latter, so that whatever is said of the edition under review will apply equally well to that which appeared earlier.

Part I of this work is devoted to an analytical treatment of the subject and Part II to a graphical treatment of the same problems. The idea which pervades the book seems to be to so arrange the results or conclusions reached, and the course of reasoning by which they were reached, that they may appeal separately to the reader or be taken in conjunction by the student who wishes to go into the development of the subject more minutely. The plan of giving two solutions to every problem—an analytical one and a graphical since, is also an admirable feature—all minds are not equally susceptible to the same method of treatment.

The scope of the work is to start from the elementary principles of flow of periodic currents in simple circuits containing resistance and self-induction only, following this by a discussion of circuits containing resistance and capacity. Next comes the general case of circuits containing resistance, self-induction, and capacity, the question of the action of a condenser in circuit with self-induction, the cases of oscillatory and non-oscillatory charge and discharge, the neutralizing effects of self-induction and capacity, and the nature of wave-propagation in a conductor possessing self-induction and distributed capacity. Some of these subjects are illustrated by concrete examples which serve to elucidate much that would otherwise be abstruse and all of them, as before stated, are treated graphically in Part II.

One of the most attractive features of this work is the fact that it is practically self-contained. No one sufficiently equipped mathematically to read it at all will need to make reference to special mathematical treatises to enable him to follow the treatment presented. The book is certainly a model of its kind and a wide departure from the almost stereotyped mathematical treatise on the almost unavoidably mathematical subject of alternating-current phenomena.

But after all this is said we are compelled to make the inquiry *cui bono?* Mr. Charles Steinmetz, a mathematical as well as a practical electrician of international reputation and who has given especial attention to the phenomena under discussion, has recently declared that no two of the advanced mathematical theorists agree either with each other or with the facts, when discussing polyphase apparatus which involve the practical application of these theories—in a complicated form it is true, but nevertheless a practical application of these theories. It would seem probable, therefore, that these methamatical discus-

sions in their elementary aspects must involve some false premises. As a mathematical divertisement the discussion of alternating currents is charming to the mathematician, and we freely admit that it has very largely advanced our knowledge of these most interesting phenomena. Mr. Steinmetz must admit this for he himself has used mathematics as a tool perhaps as much as any one engaged in this class of investigation and with the very best of results, but perhaps it is because mathematics has been with him a tool rather than a master that he has succeeded where others have failed.

NELSON W. PERRY.

STREET-RAILWAY MOTORS: WITH DESCRIPTIONS AND Cost of Plants and Operation of the Various Systems in Use or Proposed for Motive Power on Street Railways. By Herman Haupt, C.E. Philadelphia: Henry Carey Baird & Co. [Cloth, 12mo. 213 p. $1.75.]

NOTWITHSTANDING the fact that the larger share of the street-railway mileage of the United States is to-day operated by electric power, and that the change from animal power to the new motor has practically been made within the past five or six years, it is quite evident that a large number of conservative engineers, and among them many whose opinions are by no means destitute of weight, are still disposed to consider the question of the most economical and efficient motor for street-railways—at least for municipalities furnishing a dense and heavy traffic—as one whose final solution has not yet been reached. In some instances the change from animal to electric power in an established street-railway system has been, beyond peradventure, a profitable one, but that in many other cases it has been quite otherwise is, unfortunately, equally true. As a matter of fact, the application of the electric motor to street-railway service, while far beyond its experimental stage in its relation to the traveling public, is by no means in the same advanced condition in its relations to the investors whose capital has been embarked in enterprises of this kind. The question therefore at once arises: "What are the conditions under which the electric railway is advantageous, and what are those under which it is not?" The work before us is an attempt to throw some light upon the subject of this inquiry, which at best is beset with numerous difficulties which to the practical railway-manager are sufficiently obvious.

The scope of the work is well indicated in the preface: "The object is simply to give results, with such simple explanations of principles as will be of interest and intelligible to practical men who may be called upon to contribute capital for construction, or to use their votes or influence in favor of any proposed system of rapid or local transit in cities." It is not too much to say that the author has succeeded admirably in that which he has undertaken to do. Separate chapters are devoted to horse-railroads, steam motors, cable traction, electric traction by trolley and storage, compressed-air, ammonia, hot-water, gas, and carbonic-acid motors. The fundamental principles of each plan are discussed, with brevity and yet with sufficient fullness, and the relative advantages and disadvantages pointed out with the impartiality which we have a right to expect from a veteran engineer. The most interesting and valuable part of the work, to most of those who will have occasion to consult its pages, will be the summary of the estimated cost of construction and operation of a typical street-railway under different systems. The line assumed is six miles of double track with a service at two-minute intervals. The estimates, in each case, are based upon the latest and most trustworthy statistics and returns available, the source of which is given in all cases where possible. An itemized statement of first cost as well as cost of maintenance and operation for each system is given, and the conclusion is reached, that for a line under the conditions named, the different systems rank as follows in the order of their relative economy: Compressed-air motors, overhead trolley, cable, gas motor, ammonia motor, steam motor, hot-water motor, and horse power.

The most striking feature of this exhibit is the unexpectedly favorable showing made by the compressed-air motor. While the author undoubtedly displays considerable partiality for this system, it is only

fair to say that his partiality appears to be justified by the detailed facts and figures which he brings forward; facts and figures which are not derived from theoretical assumptions, but from actual commercial practice for a considerable period of time. It would be out of place here to refer to the causes which appear to have conspired to keep the compressed-air motor in a position of obscurity and neglect, but it seems quite conclusive that these were wholly beside the question of the inherent merits of the system. The statistical information which General Haupt has here collected, evidently at the expense of much time and labor, cannot but be of great value to persons interested in street-railway property of any kind. It is rare indeed to find so much really useful material compressed into so small a compass.

FRANKLIN LEONARD POPE.

SEWAGE-DISPOSAL IN THE UNITED STATES. By GEORGE W. RAFTER, M. Am. Soc. C. E., and M. N. BAKER, Ph. D., Associate Editor of the *Engineering News*. With plates and tables. New York: Van Nostrand. [Cloth. 4to. 589 p. $6.]

THIS almost cyclopedic work is an amplification of a former work by Mr. Baker —"Sewage-Purification in America—" which was reviewed in the October (1893) issue of this Magazine. It is really more than an amplification, and its scope is perhaps best shown by quoting from the preface: "In the fall of 1891 Mr. Rafter began, at the request of the publishers, the preparation of a manual of sewage-disposal in the United States. Early in 1892 Mr. Baker began the collection, largely by personal visits to existing purification-works, of data in regard to executed works as a basis for a series of articles in *Engineering News*. Neither was aware of the work of the other until about July 1, 1892, at which time Mr. Rafter had nearly completed the task to which he had set himself, while Mr. Baker was just beginning the series of articles on executed works which have since appeared in the journal named. A comparison of data indicated that Mr. Baker's work on the executed projects, by reason of bringing the information more nearly down to date, would add to the completeness of the book, and accordingly arrangements were made for joining forces. It addition to considerably extending Part II, Mr. Baker has also made material additions to Chapter VII in Part I, and has revised the whole work so far as necessary to include any additional information in his possession. This revision brings the work down to June, 1893."

The work is divided primarily into two parts. Part I is devoted mainly to a discussion of principles and Part II to descriptions of works. Both parts are well written but Part I will of necessity be of more permanent value than Part II. If all the principles involved in the subject were accurately known, Part I would never need revision. Unfortunately such is not the case, for our knowledge of the principles underlying the purification of sewage are, in some cases, quite vague and constantly undergoing change. Part II was a much easier task, but since the character of the works must necessarily undergo changes with our ideas of the principles upon which they were built, and with our knowledge of the value of methods, we see here quite as many causes for changes as in Part I.

As illustrating how rapidly these changes are going on we may cite two methods which are attracting the widest attention, though they seem not to have been more than slightly known by the authors as late as June, 1893.

The use of destructors for the combustion of the refuse and the utilization of the resulting heat for steam purposes, and the electrolytic method, by which sea-water or salt-water is made to give up a portion of its chlorin, which in turn is employed to oxidize the organic matter. The authors give but half a page to this latter (p. 563), and the description contains almost no data of value. For the past six months a process under another name, but apparently of the same kind, has attracted the widest attention abroad.

With occasional blemishes of the kind mentioned, and which are doubtless due to developments having been made so recently, the work is an excellent one and without doubt the most complete exposi-

tion extant of the present state of the rapidly-growing science of which it treats.

NELSON W. PERRY.

ART OF COPPERSMITHING. A PRACTICAL TREATISE ON Working Sheet Copper into all Forms. By John Fuller, Sr. New York: David Williams. [Cloth 8vo. 327 p. $3.]

RANKING second to silver in malleability and ductility, or third as compared with gold (the latter being the most malleable metal known), and ranking next to iron in tensile strength,—being also an abundant metal found native in some parts of the world, in which form its color is characteristic and conspicuous, while it often lies at or near the surface of the earth,—it seems that copper must have been one of the metals earliest known, worked, and valued in human industry. Certain it is that it was employed for many purposes in prehistoric times, and that its alloys with other metals, especially tin, were in common use at a date earlier than any existing record. Coupling this with the fact that the art of printing has accumulated vast libraries in which are stored treasures of information upon almost any subject or topic possible to make an object of study or research, the assertion of the publishers of this book on the art of coppersmithing, that it is the only volume in existence devoted to the subject, will be so surprising to most readers that some will be inclined, at first thought, to dispute the statement. But, testing it by a resort to extensive subject-catalogues wherein are indexed many books in which copper and copperworking are treated more or less broadly, or specially with reference to some particular art or industry, I am bound to say that I have been unable to find any treatise besides this that inclusively and integrally deals with the important, ancient, and interesting art of coppersmithing. Surely it is time that a book so long needed both by artisans and technical schools should be supplied.

Going carefully through the book from beginning to end the reader will be favorably impressed with the pleasant simplicity of the author's style. There has been no attempt at fine writing, but constant adherence to an evidently paramount purpose, which was to describe everything with absolute clearness. The writer says, in his preface: "I did my best to tell from my own experience, in the most lucid manner, that which is called for in every-day life in three separate branches of the copper trade, supposing with each lesson there was a good boy at my side." And he has so well executed the task that I doubt very much whether any other man living could have done it better. There are so many articles of copper illustrated and described in the book (there are 475 illustrations) that one is puzzled in making any attempt to select specimen passages; besides, in a work of this kind where nearly every part of the text is closely associated with and dependent upon one or more engravings, it would be necessary to reproduce these to make any characteristic part of the text available for such purpose. What can therefore be said here in addition to that already stated is, that the treatise seems to fully justify the claim of the author, that it is entirely practical, and of the publishers, that it is exhaustive; since few will be able to name any article made of sheet copper the practical construction of which, or of some strictly analogous article involving the same methods, is not fully and clearly described in the book, from the laying-out of patterns through all intermediate steps and processes to its final completion. The book is a much-needed and welcome addition to modern technical literature, and should at once be placed in every up-to-date trade-school and technical library.

LEICESTER ALLEN.

SURVEYING AND SURVEYING INSTRUMENTS. By G. A. T. Middleton, Associate of the Royal Institute of British Architects, and Member of the Society of Architects; author of "Strains in Structures" and "House-Drainage." Illustrated. New York: Macmillan & Co. London: Whittaker & Co. [Cloth. 8vo. 112 p. $1.25.]

THIS little book, the latest of the "specialists' series," is a compilation of a series of articles by the author that previously appeared in the *Building News*. The first chapter is entitled "surveys with chain only." No engineer who has had a training in surveying without instruments will undervalue this chapter. In fact our own belief, which comes from experience, is

that a thorough training in surveying without instruments other than a prismatic compass, and perhaps a chain, is one of the most valuable branches of instruction that can be taught to the student in engineering. The chapter is well written, but might be extended so as to include surveying without the chain as well. The author sticks to the Gunter's-line chain. This has been practically abandoned in this country for the steel tape, which is also mentioned in this chapter, but not favorably.

Chapter II is devoted to instructions as to how to pass obstructions,—the methods being essentially those employed in this country. The author introduces here, however, the use of right-angle instruments—the optical square and Weldon's right-angle prism. In similar work in this country the prismatic compass is more used and has a much wider range of usefulness since not only right-angles but any other angles can be measured thereby. It, would therefore, seem that, if this work is a reflection of the practice abroad, the instruction in our best engineering schools is far ahead of that usual in England.

The succeeding chapters are devoted to "the uses of the level," "various forms of level and their adjustment," "the use of angle-measuring instruments," "the theodolite and other angle measuring-instruments," and "instruments for ascertaining distances."

Looking at this book more as an index of English practice than as a text-book,—for as the latter it could not be considered in this country,—we are struck with what appears to be an adherence to antiquated instruments and methods. For instance, an amount of space is devoted to the theodolite wholly out of proportion to the importance of that instrument with us, and the plane table is not mentioned at all. In conclusion it may be said that the latter part of the book partakes much of the nature of an advertisement of several instrument-makers to whom the author acknowledges his indebtedness for the instruments loaned for the purpose of preparing the illustrations used.

NELSON W. PERRY.

GAS-LIGHTING AND GAS-FITTING, INCLUDING SPECIFICATIONS and Rules for Gas-Piping, Notes on the Advantages of Gas for Cooking and Heating, and Useful Hints to Gas-Consumers. A Pocket-Book for Gas Companies, Gas Engineers and Gas-Fitters, for Manufacturers of Gas-Fixtures and Dealers in Gas Appliances, for Gas-Consumers, Architects and Builders, Health Officers, and Sanitary Inspectors. Second Edition. By William Paul Gerhard, C. E., Consulting Engineer for Sanitary Works, New York City. New York: Van Nostrand. [Boards. 12mo. 188 p. 50 cents.]

THIS work forms one of the Van Nostrand Science Series. The chief headings are "artificial illumination," "historical notes on gas-lighting," and on the "advantages of gas," "gas for cooking and heating purposes," "hints to gas-consumers on the proper use and management of gas," and the "rules and regulations on gas" issued by the municipal department of the city of Munich. The matter under each of these headings will have especial interest to a separate class of readers. That which will probably interest the largest circle of readers will be found under the head of "hints to gas-consumers on the proper use and management of gas." Under this head is given a very large amount of information which every user of gas should know but which most of them do not know. It is a fact that a very large portion of the consumption of gas is unnecessary for the best results and due to ignorance of simple facts and precautions, which, if known and observed, would greatly reduce the gas-bills which confront us every month. This little brochure seems to be a most excellent presentation of the subject and will be found useful to the classes of readers for which it is intended.

NEW BOOKS OF THE MONTH.

Asutosh, Mukhopadhyay—An Elementary Treatise on the Geometry of Conics. New York: Macmillan. [Cloth. 12mo. 184 p. $1.10, net.]

Beatty, J.—McKinleyism as It Appears to a Non-partisan. Columbus, Ohio: A. H. Smythe. [Cloth. 12mo. 156 p. $1.]

Bevan, D., and Coplin, W. M. L.—A Manual of Practical Hygiene. Designed for sanitary and health officers, practitioners, and students of medicine, with an introduction by H. A. Hare. Illustrated. Philadelphia: Blakiston. [Cloth. 8vo. 456 p. $4.]

Bigelow, J. J.—The Principles of Strategy. Illustrated mainly from American campaigns. Philadelphia: Lippincott. [Cloth. 8vo. 362 p., maps. $5.]

Bolles, Albert S.—The Bankers' Almanac and Register and Legal Directory for 1894. Forty-fourth year. New York: Macmillan. [Cloth. 8vo. 422 p. $3.50, net.]

Burr, F. M.—Life and Works of Alexander Anderson, M. D., the first American Wood-Engraver. Illustrated with three portraits of Dr. Anderson, and over 30 engravings by himself. New York: Burr Brothers. [Half Russia. 8vo. 3-210 p. $4.]

Cogley, T. S.—The Law of Strikes, Lockouts, and Labor Organizations. Washington: Lowdermilk. [Sheep. 3vo. 14-377 p. $4.]

Coxe, Brinton.—An Essay on Judicial Power, and Unconstitutional Legislation. Being a commentary on parts of the constitution of the United States. Philadelphia: Kay & Brothers. [Cloth. 8vo 16-415 p. $3.]

Davis, W. Morris.—Elementry Meteorology. Illustrated. Boston: Ginn & Co. [Cloth. 8vo. 12-355 p. $2.70.]

Dawson, Sir J. W.—The Canadian Ice Age. Being notes on the pleistocene geology of Canada; with special reference to the life of the period, and to its climatal conditions. New York: Scientific Publishing Co. [Cloth. 12mo. 301 p. $2.]

Denning, D.—Wood Carving for Amateurs. Second revised and analyzed edition. New York: Spon & Chamberlain [Paper. 12mo. 80 p. 40 cents.]

Dogs (The) and the Fleas, by One of the Dogs. A political and social satire. Illustrated. Chicago: Douglas McCallum. [Cloth. 16mo. 2-273 p. $1.]

Edwards, Emory.—Nine Hundred Examination Questions and Answers for Engineers and Firemen (stationary and marine), who desire to obtain a United States government or state license. New edition. Philadelphia: H. Carey Baird & Co. [Pocket-book form. 16mo. 240 p. $1.50.]

Edwards, Joseph F., *M. D.*—Edwards's Catechism of Hygiene. For use in schools. Atlantic City, N. J.: The Author. [Cloth. 16mo. 3-109 p. 40 cents.]

Fahie, A.—House-Lighting by Electricity. New York: Spon & Chamberlain. [Cloth. 8vo. 80 p. 80 cts.]

Gage, Simon H.—The Microscope and Microscopical Methods. Fifth and Revised edition. Illustrated. (Part I of the Microscope and Histology.) Ithaca, N. Y.: Comstock Publishing Co. [Cloth. 8vo. 7-165 p. $1.50.]

Glazebrook, R. T.—Heat. An elementary text-book, theoretical and practical, for colleges and schools. (Cambridge natural science manuals, physical series.) New York: Macmillan. [Cloth. 12mo. 230 p. $1, net.]

Greaves, J.—A Treatise on Elementary Hydrostatics. New York: Macmillan. [Cloth. 12mo. 204 p. $10, net.]

Hall, E. H., and Bergan, J. Y. Jr.—A Key to "Text Book of Physics" New York: Henry Holt & Co. [Flexible cloth. 12mo. 50 cents, net.]

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturers.

The Troy Laundry Machine Company, Troy, N. Y.—Laundry Machinery and Laundry Supplies. 116 p.

Electric Appliance Company, Chicago.—Electric Light, Power, Railway, and House Goods Supplies. 244 p. [Complete, compact, and convenient for reference.]

The Deming Company, Salem, Ohio.—Iron and Brass Pumps for Hand Mill and Power, Hydraulic Rams, Artesian Well Brass Cylinders, Pump Fixtures, Well Tools and Supplies. 230 p., bound.

Darner & Dutton, Cleveland, Ohio.—Motors and Trail Car Trucks. 30 p. [Street-car wheels and axles, turn-tables, motor gears and pinions, castings, etc.]

National Electric Manufacturing Company, Eau Claire, Wis.—Alternating and Direct Current Apparatus. 71 p. [Multipolar power generators and motors, transformers of any capacity, and all electrical appliances.]

Bramwell Car Company, St. Louis, Mo.—The Accelerator Car. [Greater capacity, quicker time.]

The Brush Electric Company, Cleveland, Ohio.—The Brush Arc Dynamo. 50 p. [Brush arc-lighting apparatus, etc.]

The Brush Electric Company, Cleveland, Ohio.—The Brush Electric Lamp. 30 p.

The Bennett & Peck Heating and Ventilating Company, Cincinnati, Ohio.—The True Principles of Warming and Ventilating as Applied to Schools, Churches, Public Buildings, and Dwellings; Improved Sanitary Dry and Flush Closets. 80 p. [Latest improvements in apparatus.]

The Steam Stone Cutter Company, Rutland, Vt.—Circular Descriptive of the Wardwell Stone Channeling and Quarrying Machines. 18 p.

The American Fire Engine Company, Seneca Falls, N. Y.—Piston and Rotary Steam Fire Engines. 112 p. [Hose carriages, carts, pumps for fire-boats, heaters for engine-houses, fire-department supplies, etc.]

Electric Engineering and Supply Company, Syracuse, N. Y.—Electric Light and Railway Supplies for All Systems. 140 p.

McGuire Manufacturing Company, Chicago.—Patented Electric Cable and Elevated Railroad Trucks. 60 p.

Kalamazoo Railroad Velocipede Car Company, Kalamazoo, Mich.—Steel Velocipede Cars. 35 p. [Steel-wheeled hand-cars, steam inspection cars, sugar-cane cars, etc.]

American Battery Company, Chicago.—The American Storage Battery for Light and Power. 30 p.

William Sellers & Co., Philadelphia.—Hydraulic Testing Machines. System of A. H. Emery, C. E. 14 p.

Hartman Sliding Blind Company, Crestline O.—Hartman's Patent Inside Sliding Window Blinds. 95 p.